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SEA POWER AT THE END OF THE NINETEENTH CENTURY.

By W. Laird Clowes.

THERE is coming a time when sea power, meaning what it now means, will cease to exercise a dominant influence upon the political and commercial affairs of the world. Instead of the sea, the air must some day become the great international highway for trade and travel; and, when that consummation shall have been reached, the immemorial laws which were enunciated by Cicero, Hungerford, Raleigh, Bacon, and Vernon, long before they were codified and annotated for us by Mahan, will no more affect human transactions. It is very probable that the age which shall witness this deposition of the sea from its ancient strategic supremacy will witness also the practical realisation by mankind of the fact that the sea contains, stored within it, other sources of wealth and dominion. We have as yet scarcely begun to utilise the energy of the tides and the currents; and it may well happen that, when our argosies and fleets traverse the air instead of the water, the ocean shall furnish us with the raw force which we shall tame and harness to our aerial ships. But, at present, we are, apparently, little nearer to this—to my mind inevitable—development than we were when the brothers Montgolfier sent up their first balloon. In other words, the supremacy of sea power, threatened though it has been ever since 1783, is likely yet to stand firm for many years,—possibly for many generations. Thus far, at least, its position has not been shaken.

Although, nevertheless, sea power still means all that it ever signified, and although it is even a more desirable possession to-day than it was in the past, it is necessary to bear very clearly in mind that the conditions under which sea power can be exercised have in recent years undergone remarkable and rapid changes, and that the process

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of change becomes yearly more and more rapid. To put it otherwise, several of the factors which now go to build up sea power are quite different from what they were half a century ago, and not quite the same as they were so recently, let us say, as last winter. Every war, almost every discovery or invention, every political revolution, every considerable commercial movement, modifies, more or less, the terms upon which sea power is to be grasped and held. In the days of Nelson—as at any time during the previous two hundred years—the terms were comparatively simple and few, and relatively immutable from generation to generation. The main factors were commerce, fleets, the outlying possessions of a nation, geographical position, personnel, and mobility. Commerce was, as it still is, the true mother of sea power, and it had to be protected; but in those days the temporary dislocation of commerce never meant half what it means now. Nearly all countries were self-supporting, except in the matter of pure luxuries; and they could make shift to struggle on for a season without supplies from abroad. Fleets could then be built with equal ease and speed in almost any civilised land, and it was very rare indeed for a country to obtain her men-of-war, or the weapons wherewith to arm them, from abroad, except by process of capture. Nor did the fleets of different powers, different builders, and different generations vary very much. From the material point of view a Spanish three-decker was as good as a French or a British one; and a ship, when once built, continued, if taken care of, to be fully fit for the kind of service for which she had been originally designed, until she was destroyed or fairly worn out. The Victory, a crack ship in 1805, and even several years later, dated from 1765; and there were in active commission at about the time of Trafalgar much older men-of-war than she was. In those days oversea possessions were all, or nearly all, mere dependencies. The self-governing colony was unknown; the manufacturing colony was still awaiting development; the colony as a field for the investment of immense capital was almost undreamed of. As for geographical position,—at first sight, surely, a most immutable factor,—it possessed a significance which it has since partially lost. In the days before the advent of steam, the ability of a ship or of a fleet to leave or make a given port depended to a large extent upon the prevailing winds; and problems connected with blockade, invasion, and combined movements were thus placed upon bases altogether different from those which they now occupy. It was possible, for example, for Bridport or St. Vincent to lie for weeks together at Spithead or in Torbay, assured that the Brest fleet was safe in its harbour, if only for the reason that the wind was such as prevented it from coming out. Even the personal problem was, relatively, a plain and easy one in

the old days. It was often necessary, it is true, to offer extravagant bounties, and to resort to the iniquities of the press, in order to procure such men as were needed in excess of the ordinary peace establishment, whatever it happened to be; yet, when the men had been obtained, the problem was much more than half solved; for it was possible, in six or even in four months, to train the rawest landmen to become very respectable man-of-war's men.

All the factors of sea power which I have so far glanced at have entirely altered in character, and in their relationship both to one another and to the whole situation, since the wars of the early part of the present century. The result is that, although, like the laws of electrical energy, the laws of sea power are really exactly the same as they were in the days of our grandfathers, sea power, like electricity, cannot now be understood and fully taken advantage of, unless it be looked at in the light of knowledge, and directed by methods and machinery, of which our grandfathers never dreamed. As far as electricity is concerned, this truth is, of course, the dullest platitude. But it is not, I think, a platitude as regards sea power. Electricity is a force the practical application of which is hourly and anxiously studied by numbers of trained and experienced intellects. Sea power, on the other hand, is a force the practical application of which has received hardly any attention. We have been told, by Mahan and others, what sea power is, and what sea power has effected and may yet effect; and we are from time to time assured that intelligence departments and boards of strategy are at work on the elaboration of plans of naval offence and defence with regard to special situations and eventualities. But we have no reason to believe, and every reason to doubt, that the broad problem of the bearing, upon the laws of sea power, of modernised factors and of altogether novel conditions has ever yet been intelligently and scientifically studied. The time for the scientific study of the application of sea power has surely arrived, unless, indeed, our recent awaking to the influence of sea power upon past history is to be of no practical benefit whatsoever to the science of war, and of no utility to the cause of peace.

I daresay that I shall be charged with having overstated the case, and that I shall be told, firstly, that the subject already receives sufficient attention, and, secondly, that, after all, there is little to be studied in connection with the matter. Nevertheless, if space permitted, I could, I think, by taking *seriatim* each of what I have ventured to call the main factors of sea power, show that, to this day, those powers which have navies, and which aspire to make use of them, are proceeding almost as blindly, as unsystematically, as un-

scientifically, and as uneconomically as they could proceed if no intelligent appreciation of the laws and influence of sea power were open to them. Nay, more, I could, I think, convince my readers of the correctness of my contentions. Since space does not permit, I will confine myself to the consideration of a single point by way of illustration.

I have mentioned, among the main factors of sea power, mobility. It is now one of the most important factors, because it is a factor in which it is possible for any naval nation—even one of the third rank—to crushingly excel its bigger rivals. In the old days mobility had not quite its present importance, and certainly it had not anything like its present possibilities. One line of battleship might then be faster than another, but not much faster; one constructor might build quicker than another, but not much quicker; one fleet—care and foresight being equal in both—might keep the sea longer than another, but not much longer. Given equality of numbers and personnel, two navies were then necessarily very much on a dead level, until the weather interfered; and the weather, inexorably and impartially, by turns aided and hampered both. The weather is not the only element which has now ceased to have its old influence upon the factor of mobility, but, in order that we may fully grasp the extent to which the conditions have altered, and how unequally they now influence different countries, we must stay to enquire what mobility, as one of the great factors of sea power, means.

It means, broadly and briefly, the digested science and practice of creating with the greatest possible promptitude the best and newest engines of naval warfare; of moving those engines with the highest possible intelligence and rapidity to the points at which they shall be capable of rendering the greatest service; and of preserving those engines in all circumstances in the best possible state of readiness and efficiency. Analysed more strictly, the elements of naval mobility are: facility for rapid manufacture and construction; quick collection, collocation, and dissemination of intelligence; a fast-working mobilisation system; ships of high speed and coal endurance; and organised machinery for the speedy making good of waste and expenditure.

In the days of wooden ships, all the naval powers could, at a pinch, build with about equal rapidity. A vessel could be laid down upon almost any beach that sloped into moderately deep water; and the foundries and shops of any country, save the most insignificant, were fully equal to the fitting and arming of the finest three-decker. But, in these days of steel, some countries, unless they import nearly all their materials in manufactured form, cannot build a battleship at

all; and none can build battleships, or even smaller men-of-war, except in particular localities. Some cannot complete a battleship in less than five or six years; others can do it in two, and can even finish a large cruiser in one. Some make their own guns and ammunition; others cannot do so, and have to import part or all of what they need. In their ability to obtain, collocate, and disseminate intelligence, the various naval nations start with more equal advantages. In peace-time, at least, all have equal command of *attachés*, secret agents, technical advisers, the posts, and the telegraphs. There are very few naval secrets; and the majority, even of those few, are practically open ones. Such advantages as these lie with the wealthier and better-educated States; but, for all, the business of the intelligence department is immeasurably a simpler matter than it was in the days when international intercourse was difficult, and when such things as a cheap press, special correspondents, and submarine cables were unheard of. Mobilisation also is a far easier thing than it used to be. Telegraphs, steamships, and railways facilitate it immensely. But all countries do not possess equal facilities for it. The facilities must, to a large extent, depend upon natural conformation, and upon the proportion borne by the telegraph and railway mileage to the area of the land. Speed is the element which has most influenced the factor of mobility. The limit of speed in the old days was, for a frigate, about fifteen knots, and, for a line-of-battleship, about twelve. No ability on the part of the constructor, and no expenditure on the part of his employers, could produce much greater speed than that; and even that could be attained only in the most favourable conditions. An adverse gale might mean the impossibility of any progress at all. We do not know what are now the limits of speed. We know only that we have not yet attained them, and that we have already attained speeds up to about thirty-six or thirty-seven miles an hour in smooth water. In the meantime, we have large ocean steamers which do their twenty-two knots, in good weather and bad, with almost the punctuality of railway trains, and which are capable of carrying coal to take them more than half way round the world at that speed. Just as all countries have not equal facilities for building modern warships, so all countries have not equal facilities for building vessels of extreme speed. And, apart from purely military purposes, it is worth the while only of those countries which have extensive sea-town commerce, and large commercial marines, to build or purchase ocean greyhounds of the fleetest types. In point of fact, all the fastest liners and merchantmen in the world belong, or belonged until the last few weeks, to Great Britain, Germany, the United States, and France; and all the fastest men-of-war in the world have been constructed either in Great Brit-

ain, Germany, the United States, Italy, or France, or by workmen of those countries. As for organised machinery for the speedy making good of waste and expenditure, it is now much more difficult to create it than was the case in the old days. Ships are less self-contained than they used to be. They need continual supplies of coal; in action they expend their ammunition much more rapidly than of yore; and they are of more delicate constitution than their wooden and masted predecessors. Moreover, coal, like steel, is not produced everywhere. Some countries can dig it; others must buy it; and, as it is the very life of every man-of-war, it is indispensable. Again, the commercial countries can handle and transport it, and other necessary supplies for a fleet, more readily than the uncommercial ones; and the shipbuilding and commercial countries have, of course, the best facilities for keeping their men-of-war in permanent efficiency, both as regards material condition and as regards fuel and stores.

Now let me come to my point, which is, as has been said, that, although, in these closing years of the nineteenth century, we understand better than ever the laws of sea power, and the manner in which sea power has influenced history, and must for the present continue to influence it, we have not as yet seriously studied and made a science of the application of sea power under modern conditions.

There is, I believe, no country, save perhaps Germany, wherein the theory of modern naval warfare has received more attention than in the United States. The navy department has for years been most admirably served abroad by a large body of naval *attachés* of exceptional energy and ability; much of the intelligence collected by these *attachés* is from time to time embodied in the invaluable series of volumes entitled "Information from Abroad," and is thus circulated throughout the United States navy; the Naval Institute at Annapolis disseminates other professional literature, superintends the discussion of all important questions connected with service matters, and keeps its members constantly supplied, as it were, with a mirror of the world's thought and work on naval subjects; and, in the naval war college, America has had the advantage of a strategical and tactical school such as had never existed elsewhere. If, therefore, any country is in a position to understand the methodical application of sea power, it should be the United States. But the truth unfortunately is that neither there or elsewhere are either the citizens or the government officials as yet capable of deducing from the facts at their disposal the lessons which are patent enough to thoughtful naval officers and to intelligent specialists. In constitutional countries, a navy is what it is,—large or small, efficient or inefficient,—not in pursuance of the will of the officers, but in pursuance of the will of

the nation. Since there is now growing up, almost everywhere, a keen popular appreciation of the value of sea power, I do not give up hope that, in the future, there may also grow up a popular realization of the modern problems affecting the application of sea power. But that time is not yet; and meanwhile we are wasting half of the huge sums which we annually spend for naval purposes, simply because we do not know how to spend them intelligently.

If what I say were not true, how different would have been the opening incidents of the Hispano-American war! It must now be evident to all that neither side applied in the right way and to the best advantage such sea power as it possessed. Let us, in continuation of what I have already advanced, glance at the attitude of the combatants with regard to the single factor of mobility. As between the United States and Spain there is no question that the former country ought to have held and played all the trumps in this particular hand of the game. She held the trumps, indeed, but, apparently, she did not know how to play them. She has for years possessed immeasurably greater facilities for rapid manufacture and construction; she has for years had at her disposal better machinery for the quick collection, collocation, and dissemination of intelligence; it is her own fault,—supposing it to be the case,—if her system of mobilisation is the slower-working of the two; there is no reason why any of her ships of war should be of lower speed and worse coal-endurance than those of a poor country, like Spain; and, moreover, she actually had at her command, at least up to the moment when war became imminent, more fast merchant ships than Spain. Finally, she has long had at hand far better materials than Spain for creating an organized machinery for the speedy making good of waste and expenditure.

Looking to all these considerations, I do not hesitate to say that, on the strength alone of her vastly superior capacity for mobility, the United States ought—had she known how to apply this great factor of sea power, and had she so applied it—to have reduced her enemy to impotence within a few days of the outbreak of the war. That she did not do so was her fault, not necessarily Spain's merit, although certainly Admiral Cervera seems to have displayed much strategic ability.

Every American realizes, more or less vaguely, that it is necessary for a country so large and so important as the United States to possess a navy. But American public opinion, when, about twelve years ago, it came to the conclusion that it must have a navy of modern construction, was not sufficiently intelligent to put to itself certain weighty questions. It did not ask itself: "Is it not likely that some

day we shall have to meet European opponents? Is it not a maxim of naval, and, indeed, of all, warfare that the only good defence is offence? Is it not also a maxim of naval warfare that your enemy's coasts are the most effective fighting-ground for your fleets? Is it not a fact that, seeing that America is very far distant from any of the great naval countries, her war ships, which may have exceptional distances to traverse, should have exceptional speed and exceptional coal capacity?" On the contrary, American public opinion, not having studied the science of the application of sea power, demanded comparatively few fast ships, gave to the majority even of these no very exceptional coal endurance, and positively insisted that its heaviest and most formidable ironclads should be fitted rather for the defence of the coast-line of the United States than for operations in the waters of the far-off foe. Thus did American public opinion cripple in its infancy the mobility of the new American navy. A few faster and more enduring ships have been built since; but much time was lost, and much money was wasted. Nevertheless, even when war became imminent, America had it in its power to partially compensate for the defective mobility of the bulk of its fighting fleet. It had it in its power to buy up and to utilise a very large proportion of the fastest ocean liners of the world. It hastily purchased several; but it can hardly be said that it utilised them properly. The best part of the Spanish fleet was still in Spanish ports. It could be found when wanted. It should surely have been watched from the beginning, and destroyed so soon as it ventured to sea. And it might have been. To make up for the relatively small coal-endurance of the majority of United States men-of-war, the Canary Islands might, if desirable, have been seized to serve as a coaling base; the heavy ships, accompanied by colliers, might have been stationed there; and the fast ships and the mercantile cruisers might have been stationed off Cadiz and Ferrol, so that nothing could escape without the fact and all necessary particulars being promptly reported to the battle-ship squadron. But nothing of this sort was attempted; nothing of this sort was apparently even contemplated by the United States government and by American public opinion. I am sure that it was contemplated, and I suspect that some scheme of the kind was urged, by many naval officers; but public opinion would not have allowed such a plan to be carried out. The people, knowing nothing of the application of sea power, would have insisted that the proper station of the main fleet was on the western side of the Atlantic. The consequences were that the fleet of Cervera was able, unwatched, to leave its ports, and to make rendezvous at the Cape de Verdes; that it was able to disappear thence, the Americans

knew not whither; that some of the Atlantic coast-towns of the Union, imagining that the Spaniards were about to raid them, were seized with panic; that the safety of the Oregon, coming from the Pacific, and of the Nictheroy, coming from Rio de Janeiro, was for a time almost despaired of; that Cervera, after having remained invisible for a fortnight, turned up in the very waters which he should never have been allowed to reach; that, for another fortnight, he remained in those waters without the Americans being able to bring him to action; and that, on more than one occasion when the Americans had a chance of catching him, they were rendered temporarily impotent by the condition of their bunkers, and by their inability to fill up with fuel without going to Key West. Delay, anxiety, and expense were the penalties paid by the Americans for their neglect to use from the beginning, and to the utmost, all the advantages of mobility which were, or which, had they willed it, might have been, at their command. Neglect of this kind, especially at the commencement of a war, does not, as we have often seen in the course of British history, necessarily jeopardise the ultimate issue; but it postpones it, and it makes it many more times costly, in blood as well as in treasure.

I have ventured to use these episodes of the Hispano-American war as illustrations of my contention that we have not as yet seriously studied and made a science of the application of sea power under modern conditions: but far be it from me to suggest that America is in this respect different from other naval nations. All equally neglect the importance—the supreme importance—of speed and promptitude in every matter connected with the organisation and handling of a modern naval force. We have seen recently how the British admiralty took a fortnight to mobilise Admiral Dale's particular service squadron, when, according to its previous declarations, it ought not to have taken more than three or four days; how it went to sleep over the armour question, and, dreaming that certain armour was temporarily unobtainable, announced it as a fact; and how, in spite of its facilities for acquiring information, it had to be set right by the morning papers on the subject of the number of men-of-war under construction for Russia. We have watched, too, the weary voyage of the Deutschland to the far east. Upon the whole, there are probably few powers which, at the test, would do much better than America has done.

Yet that reflection is only negatively satisfactory. We may be sure that the unscientific method of preparing for war and of waging it is always, in the end, the most expensive way; and we may take it that, while no factor of sea power can be neglected with impunity,

the neglect of no factor is so fraught with danger, suspense, anxiety, and waste of money as the neglect of that group of elements which I have classed as constituting mobility. Those elements are all of great importance; but at the head of them stands, undoubtedly, speed,—locomotive speed,—with, as its complement, coal endurance. We are told that every warship is, of need, a compromise. But there are wise compromises and foolish ones. The compromise which, in any serious degree, sacrifices speed to guns, armour, and magazine capacity, seems to me to belong to the latter category. The lesson of all recent naval wars is that the point upon which it is most perilous to make concession is the point of speed. The battle of Angamos, the battle of Hai-yun-tau, the westward voyage of Cervera, lead to the same conclusion; and so plain does this conclusion appear to my mind that I am inclined to regard it as little better than waste of money for a naval power now-a-days to deliberately design and lay down any vessels which shall have less speed than vessels of corresponding classes in the navies of other nations. If France builds, as she is actually building, an armoured cruiser to do her 23 knots, the new armoured cruisers of Great Britain should surely be 23-knot, if not 24-knot, vessels, and not, as will be the case, 21-knot craft. And so with battleships, protected cruisers, and torpedo-vessels. You cannot afford to compromise on the element of speed to a greater extent than your neighbours have compromised or are compromising. Some powers have already begun to realise and to act upon this truth. The Argentine Republic—though, in common estimation, but a fourth-rate State—has spared neither pains or expense to acquire the fastest cruisers in the world. In the Buenos Aires, the Nueve de Julio, and the 25 de Mayo, she has three ships which no other country can parallel. Chile, also, has started upon the same wise course. Fast ships are naturally of little value, unless there be behind them knowledge and organisation, and in them science and bravery; but we may be sure that, other things being approximately equal, speed will tell more than any other single factor in the naval warfare of to-day and to-morrow; and we may, I think, rest assured that, although speed is one of the most expensive requirements of a navy, it is, in the long run, the most economical, because it is the most time-saving, anxiety-saving, and money-saving quality with which we can endow a warship.

In certain classes of her ships Great Britain has neglected speed more than most naval nations; and it would be well if the country would quickly rouse itself to this fact, and insist upon a change of policy. I do not, of course, speak of her torpedo-boat destroyers, which, at present, leave nothing to be desired. I speak of her bat-

tleships and her cruisers, and particularly of the latter. We are accustomed to think of the Powerful and Terrible as cruisers of exceptional speed as well as of exceptional force: but in reality, considering their immense displacement, they are both slow and weak. Compare one of them, for example, with the Buenos Aires above mentioned:

	Terrible.	*Buenos Aires.*
Displacement, tons	14,200	4,500
I. H. P. (nat.)	25,000	13,000
Mean trial speed (nat.), knots	22.4	23.2
Coal capacity, tons	3000	1000
Heaviest armour over guns, ins	6 in	4.5
Torpedo-tubes	4	5
Guns	2—9.2 in. B.	2—8 in. Q. F.
	12—6 in. Q. F.	4—6 in. Q. F.
	16—12 pr. Q. F.	6—4.7 in. Q. F.
	12—3 pr. Q. F.	4—6 pr. Q. F.
	9—.45 in. Maxims	10—3 pr. Q. F.
		6—1.4 in. Maxims
Weight of double broadside, lbs	2190	1150
Muzzle energy of double broadsides, lbs	70,000	53,300

The Terrible, therefore, though three times as big, and consequently perhaps about three times as costly, as the Buenos Aires, is nearly a knot slower under natural draught; carries less than 50 per cent. more coal per i. h. p.; has fewer torpedo-tubes; throws less than double the weight of broadside; and throws that broadside with only about 35 per cent. more muzzle energy. In addition, the Terrible is vastly the bigger target of the two; and, while her heavy guns are merely breech-loaders, the heavy guns of the Buenos Aires—practically weapons developing equal muzzle energy—are quick-firers; so that, although speed has obviously been sacrificed in the case of the British vessel, it is hard to see that there is even the appearance of any compensating gain.

This question of speed is one which must now rapidly rise into great prominence. It is the subject, I believe, which first demands the attention of him who, knowing the value of sea power, would study its scientific application under modern conditions.

NATIONAL INFLUENCE AND THE ISTHMIAN CANAL.

By Lewis M. Haupt.

"AMERICA for Americans." This aphorism is the embodiment of the Monroe doctrine, which is construed by some to mean that continental aggressions should be restricted to the eastern hemisphere. Unfortunately, not a few American citizens place a much narrower construction upon the edict, and appear to think that it requires the United States to restrict her operations to her own national domain, to live within herself, to take no part or lot in the affairs of other nations or powers, but so to adjust her policy as to produce what she consumes and consume what she produces,—in short, to build a wall of circumvallation about her, like that ancient structure which once separated China from the rest of the world, and live within herself.

We cannot ostracise our nation, however, without denying to it the functions for which it was created and the high duties and purposes of enlightened Statehood and international comity. The civilizing influences of the Christian nations of the earth cannot be restricted by geographical limits. They are rapidly penetrating the heart of Africa and sweeping through central Asia on bands of steel, while the Star of Empire is rolling westward with giant strides to awaken the occult and populous dynasties of the orient to a new and more vigorous life.

While the massacre of the Armenian Christians excited the sympathy and surprise of America, the eastern question was so complicated (especially in its financial relations) that no one of the powers seemed willing or able, in the interests of humanity, to intervene. With the massacre of the reconcentrados in Cuba and the protracted efforts of these long-suffering people of the Cis-Atlantic to free themselves from oppression, the case was different, and a climax was reached when the innocent officers and crew of the Maine were sacrificed in a port supposed to be friendly. Was this an accident? Was it accidental that, while all eyes were focussed on Cuba and the preparations for her deliverance, the reverberations of our Pacific squadron from Asiatic waters suddenly revealed that the Philippine

Islands were in our possession without the loss of an American? Why was the Oregon ordered to make a perilous voyage of nearly fifteen thousand miles to reach a point only three thousand miles from her station, at the risk of being unable to secure coal *en route*, or of being destroyed by Spanish sympathizers in a neutral port, or captured by a detachment from the enemy's fleet off the coast of Brazil, not to mention the great physical stress to the seamen subject to climatic changes, ranging from Arctic cold to tropic heat? Was this great object lesson an accident? Nearly all of these perils, it should be noted, are incidental to the circumnavigation of South America. The sailing course round Cape St. Roque lies nearer to the coasts of Africa and southern Europe than to that of the United States, since the entire continent of South America lies east of the meridian of Florida. Pernambuco, Brazil, is five hundred miles nearer to Cadiz than it is to New York. So is San Francisco, by water. Is it unpatriotic to wish it otherwise? If it were a physical possibility to transport the commerce of the west coast of the United States and place it ten thousand miles nearer, by water, to the eastern and Gulf coast, for a small consideration, would it not be a national disgrace if we failed to utilize so vast an economy? Yet this would be the practical effect of opening a canal across the isthmus. Can any one doubt its utility?

The chief element in effecting the rapid transformation of the peoples of the earth, thus briefly referred to, is transportation. Between continents the waterway is already prepared and maintained; it is necessary only to provide the vessels and open the ports.

For international commerce, that nation has the supremacy which has the cheapest and best system of ocean transportation, and which can utilize her movable plant to greatest advantage. This necessarily involves economic speed, short runs, dispatch in handling cargoes, cheap and durable construction, and economic management, most of which factors are functions of the time required to make a round trip. If, therefore, any time can be saved, without increasing cost, there will result a corresponding economy, and the best way to save time is to shorten distance. Thus the old expedient of cutting artificial channels through obstructing peninsulas has long been recognized as justifiable and desirable; yet there is one section of the earth where such a highway of commerce, although sought for nearly four centuries, is not yet an accomplished fact,—namely, the Isthmus of Darien.

Probably at no place on the globe would the economy in distance be so great as here, and certainly nowhere else has so assiduous search been made for a passage between the two oceans. Nearly all com-

mercial nations have sent out expeditions to discover the "Secrets of the Straits," believed to exist between the Atlantic and Pacific. It was the dream and hope of Columbus, in 1502; of Pinzon, in 1510; of Balboa, in 1513; of Davila, in 1522; of Verrazano and Cortez, in 1523; of de Cordova (who took possession of the outlet of the San Juan del Nicaragua), in 1524; and of Gomez, in 1525. But they were doomed to disappointment.

Antonio Galvao explored the river leading from the great lake of Nicaragua in 1529, and about 1536 Antonelli followed in his footsteps, but during the reign of Philip II—1527-1598—little was done by Spain, as his majesty is quoted as having said that the Lord had placed the Cordilleras across the isthmus as an evidence that they were not to be pierced.

In 1698 the broad-minded Scotchman, Wm. Patterson, attempted to establish a colony, but was driven out; again, Lord Nelson penetrated to Viejo Castillo in 1779, but was obliged to abandon his efforts. Yet these failures did not deter others, among whom may be mentioned Baron Von Humboldt, Gov. de Witt Clinton, Commodore Vanderbilt, Childs, Trautwine, Kennish, Strain, Michler, Shufeldt, Selfridge, Lull, Heuer, Mitchell, McFarland, Menocal, Wise, Eads, Peary, Davis, Dutton, and Ludlow. Many of these were carefully-conducted scientific expeditions resulting in the accumulation of considerable data; some were merely reconnaissances; but they all contributed to throw light on the feasibility of the problem, which is now generally admitted, and to narrow the practicable routes down to possibly two, which it is not the intention of the writer to discuss at this time.

The feasibility of the canal being admitted, its construction becomes a question of *expediency*, and this involves other broad considerations.

The first is that of economy; a second, that of policy or diplomacy; a third, that of ability; a fourth, that of cost. Most of these have been so ably considered by Prof. Keasby in his work on "The Nicaragua Canal and the Monroe Doctrine" that it must suffice to refer to his presentation for specific statements of both history and fact.

As to the general economy of this work, it is difficult to form an estimate in dollars and cents, yet a good approximation to it may be derived from the preliminary basis prepared by Mr. F. W. Kelly, of New York, from the official returns for 1857, given in a report of Rear Admiral Davis, dated July 11, 1866*, from which the following extract is taken.

* See Ex. Doc. No. 62, 39th Congress, 1st Session (Senate).

Table showing the total tonnage that would pass yearly through he isthmus canal, if now finished.

I

	Tons.
United States	1,857,485
England	1,029,295
France	162,735
Other countries	44,555
Total	3,094,070

II

Table showing the value of the tonnage and trade of the

United States	$193,168,937
England	190,649,584
France	67,210,609
Other countries	16,802,000
Total trade affected by the canal	467,831,130

III

Table showing the saving in money to the trade of the United States that would result from the use of the isthmus canal; according to the official statistics for 1857.

Insurance on vessels and cargoes saved	$3,863,378–2%
Interest saved on cargoes	3,008,840–1.5%
Saving of wear and tear of ships, 5%	4,643,712–2.4%
Saving of freight money (by time)	11,250,000–5.8%
Saving of wages, provisions, crew, etc.	13,230,000–6.8%
Total yearly saving to the United States	35,995,930

Or 18⅔ per cent. of the trade of the United States, as given in table II.

IV

Table showing the yearly saving in money to the trade of England, as ascertained by the official returns of 1856, if the trade passed through the isthmus canal, instead of round the capes.

Insurance on vessels and cargoes	$1,906,495–1%
Interest on cargoes	1,858,826–1%
Saving of wear and tear of ships	2,573,237–1.3%
Saving of wages, provisions, etc.	3,611,700–2%
Total yearly saving to England	9,950,348

Being 5¼ per cent. of the value of the trade of England.

V

Table showing the saving in money to the trade of France that would result from the use of the isthmus canal, according to the official statistics for 1857.

Insurance on vesels and cargoes	$753,000–1.1%
Interest saved on cargoes	452,084–0.67%
Saving of wear and tear of ships	325,470–0.5%
Saving of freight money, estimated by time	276,949–0.4%
Saving of wages, provisions, and outfit of ships	376,427–0.56%
Total yearly saving to France	2,189,930–3.3%

Or 3.3 per cent. of the value of the French trade.

This indicates that the greatest benefits would accrue to the commerce of the United States, and that the saving in about three years would probably equal the cost of the canal.

Table showing the *saving* to the trade of the world by using the isthmus canal.

United States	$35,995,930
England	9,950,348
France	2,183,930
Other countries*	1,400,000
Total	49,530,208

"Exports of Great Britain increased one hundred and seven per cent. in ten years. Exports of France increased one hundred and thirty per cent. in ten years. Exports of the United States increased ninety-three per cent. in ten years. If the trade increases one hundred per cent. in the next ten years, the saving to the world will then be $99,060,416 per annum."

It will be seen from these statistics that none of the Asiatic or Australian trade, developed in recent years, is included in the above estimates, yet this would properly form a large part of the tributary traffic. But the most suggestive conclusion to be drawn from these figures is the supreme importance of creating such a waterway to prevent the enormous waste inflicted upon the commerce of the world by its non-existence.

For, if, as is stated, the trade increases in value at the rate of one hundred per cent. in ten years, or ten per cent. per annum, and the saving to the trade follows the same law, then it must result that, in the forty years which have elapsed since 1857, when the saving was $50,000,000 in round numbers, the percentage of increase will be

* Equated from the trade of England, France, and the United States.

four hundred, and that the waste due to the non-existence of this canal would now amount to $200,000,000 per annum,* or more than double the total estimated cost as determined by the board of experts of May 9, 1889 ($88,000,000); so that, while valuable time is being consumed in attempting to determine the probable, actual cost within narrow limits, the commerce of the world is subjected to a loss of many times the total cost of the canal, whatsoever it may be found to be, which loss is a tax upon all nations, but chiefly upon ourselves.

While it may not be probable, since the opening of the Suez canal in 1870, that so large a percentage will use the Darien route, yet the experience at the Sault Ste. Marie Canal serves to impress the belief that it cannot be far from the truth; for, after the first enlargement of this canal in 1870, the registered tonnage increased 3.6 times in twelve years. The canal was deepened in 1883 to a 16-foot draught, and, in consequence, the traffic doubled in three years; it doubled again in four years, and it was again more than doubled last year, as a result of the increased facilities provided by the enlarged "Poe" locks, opened August 3, 1896. The reported traffic for 1897 reached the astonishing aggregate of 18,954,000 tons, being an increase of 11 per cent. over the previous year, while the average ton-mile charge was only .83 of a mill. The freight receipts earned by this traffic aggregated more than $13,000,000 for the year.

This means that, in the brief period of sixteen years, the traffic has increased 1,109 per cent., which is far in excess of the estimate of Mr. Kelly, and illustrates the importance of a broad-minded consideration of these economic questions of transportation by water.

Of this experience the late Col. Poe, United States Corps of Engineers, very pertinently said: "For thirty-five years I have watched the increase of the great lakes commerce, but neither I nor anyone else has been able to expand in ideas at the same rate. The wildest expectations of one year seem absurdly tame by the side of the actual facts of the next."

The figures presented are, therefore, very suggestive and serve to give an idea of the enormous tax placed upon commerce by the failure to open this waterway.

With so great economy to result from the construction of a trans-isthmian canal, the question may well be asked: Why then has it not been completed long ere this?

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*From the Report of "Commerce and Navigation of the United States" for 1897 it is found that the total value of the trade for that year aggregated $1,814,000,000; so that the increase in value in the past forty years would be $1,621,000,000, or about 840 per cent., instead of 400, as estimated on the basis of Admiral Davis's report. At this rate the economy per annum would reach $420,000,000, if the canal were opened. Should this great waste be longer continued?

The answer must be found in the history of all great undertakings. First, it required some centuries of exploration to ascertain the proper route; second, when discovered, the problem seemed to be beyond the mechanical and financial resources of the times; third, as it was developed, expanded, and adapted to the increasing demands of commerce, additional obstacles and difficulties were presented, of a complicated nature, but having little to do with the physics of the problem, as follows:

All great and valuable concessions excite the cupidity of mankind, while vested interests fear a division of profits and diversion of business by competing routes. It consequently happens that the most powerful interests which might be expected to be allied against it for self-preservation would be the Panama Canal, the Tehuantepec Ship Railway, the Southern Pacific Railroad, and the Suez Canal. This seems to have been the case; but a broader consideration of the general effects resulting from the construction of such works should soon dispel all fears, leaving no doubt in the minds of the owners of these several properties, or interests, that only good can result to them from this canal Were there space, this matter of the beneficial effects of deep waterways on competing railroad lines could be abundantly established, but we must be content with a mere reference to a few brief papers on this important law of development, expressed in the aphorism, "*Facilities create traffic.*" *

Notwithstanding the very low charges for through freights by rail, there are many kinds of basic materials necessary to encourage industries which cannot bear the charge, and are either carried by ships around the Horn, at a cost one-seventh that by rail, or are left dormant in the earth. As the average ton-mile rate by rail is .85 of a cent, this for 3,000 miles makes a charge for transportation alone of $25.50 per ton, which is much more than many such products are worth, leaving nothing for mining, hauling, storage, and other expenses; whereas a charge of, say, $3.50 per ton *via* "the Horn"

* See Address of O. B. Potter before N. Y. State Canal Convention, 1892.
" " " S. C. Thompson, Proceedings Deepwaterway Convention, 1895.
" " " L. E. Cooley, " " "
" " " L. M. Haupt, " " "
" ENGINEERING MAGAZINE, April, 1892, etc.

The president of the New York Central and Hudson River Railroad, Mr. Chauncey M. Depew writes: "I have always thought the existence of the Erie canal a benefit to the New York Central Railroad, and have therefore favored every movement which liberalized its management or promoted its interests."

And the president of the Chesapeake & Ohio Railway Company, Mr. Ingalls, also takes an advanced position on this question, going so far as to say: "Improvement of the waterways always helps the railways, for the development of the waterways makes business, and the railways then get the higher-class freight."

The improvement of the Great Kanawha has greatly increased the tonnage of the railroads skirting its banks.

gives to many products a commercial value they could not otherwise obtain, and renders them marketable. The isthmian canal would still further enlarge the range of materials available for manufactures, and increase the movement in products carried by rail at higher rates, leaving a much greater margin of profit, and thus enabling us to compete more successfully in the markets of the world.

It should be observed also that the actual rate per ton-mile is but one-tenth as much by the lakes as by rail, so that freight may be carried ten times as far at the same cost, or, for an equal length of haul, ninety per cent. of the charge may be saved. Thus the great difference in relative rates would extend the market range one hundred fold (as the square of the distance), which constitutes another impressive reason for the early construction of this highway of commerce.

The prestige of maritime nations, in peace as well as in war, depends upon their sea power, and that is in turn dependent on commercial outposts, refuges, and coaling stations, of which as yet we have practically none; hence we are dependent upon our commercial allies for all such service. The necessity for such outposts is now being impressively demonstrated, and should leave no doubt as to the importance of opening the canal and accepting the overtures of Hawaii for annexation, since it occupies a strategic position in the Pacific.

There are many other cogent reasons why a canal traversing the American isthmus should be built and operated by the United States, but the foregoing must suffice to show that it is a national, if not an international, duty for the United States to construct and maintain the canal. It seems to be her manifest destiny, forcibly impressed by existing conditions, to open a highway for civilization to the east, to enable her to control and defend her commerce and territory on the Pacific and Alaskan coasts, and to bring them nearer to her own base of operation than to the bases of operation of either Europe, Asia, or Africa.

This waterway would save greater distance in proportion to its length than any existing or possible canal on the globe. It is admitted to be feasible; it is shown to be expedient and enormously economical; and it is believed that, instead of being injurious, it will prove beneficial to all existing routes of transportation.

Its most determined opponents are jealousy and avarice, and not until they are overwhelmed by piety and patriotism may it expect deliverance from its enemies. Then, the pen of the president, like the rod of Moses, will be stretched out, "and an highway shall be there, and a way * * * and wayfaring men, though fools, shall not err therein."

SOME FEATURES OF INDIAN RAILWAYS.

By J. W. Parry.

THE unique position attained by the Indian railways as successful pecuniary undertakings and safe investments of a superior class is beginning to attract the notice of capitalists and financiers. For we find that, while English and American railways pay 2½ to 3½ per cent. dividends, and the Australian system is worked at a loss, the Indian lines earn 4 to 9 per cent. on the subscribed capital. The average return, even in this famine year, when trade was disorganised, is given as 5.2 per cent. for all the railways taken together, while it is fully anticipated that the average for the financial year ending March 31 next will be 5¾ per cent. The share value of every Indian railway quoted on the Stock Exchange is at a premium. Can this be said of the railways of any other country?

Just two years ago the Rothschilds took over the Burma system of railways from the secretary of State for India, on what were considered hard terms,—namely, a guarantee of 2¾ per cent. plus half profits for 21 years. Burma is a country likely to develop rapidly, and the Rothschilds are not men to accept such terms unless they feel confident either that the investment will be immediately profitable or that it has possibilities for the future not easily to be found in home and foreign markets. The question then arises: What is the cause of the success of Indian railways? Are the lines run up anyhow? Are they jerry-built? or does India possess some inherent advantage over England and America? Before replying to these questions, I will try to remove certain erroneous opinions held even by experts who pose as authorities on Indian railways because they have made a six months' cold-weather trip to the gorgeous east.

In the first place, then, it is necessary to state that the main arterial lines constructed in the early days—namely, the East Indian, Great Indian Peninsula, Madras, and Bombay-Baroda systems—were by no means as cheaply built as some suppose. Each of these systems cost more than two lakhs of rupees per mile when the rupee was more than two shillings in value,—in other words, more than £20,000 per mile. Yet two of these systems—the East Indian and Bombay-Baroda—in ordinary years earn 7 to 9 per cent. on the subscribed capital in rupees, while the Great Indian Peninsula, with its heavy gradients works crossing the Western Ghâts in two directions, Jabalpur and Raichore, and the Madras Railway, in which the serious error was made of avoiding the large towns to prevent detours, manage to

earn 4½ to 6 per cent. when the traffic is normal and a higher rate when the harvests are plentiful. Within the last 20 years Indian engineers have learned to build railways at considerably reduced rates, although the rupee has fallen in value and labour has risen in price 50 per cent., chiefly due to extended experience and keen competition. For we find in the Blue Books that the present Indian broad-gauge lines cost from £8,000 to £10,000 per mile, and the narrow-gauge lines from £6,000 to £7,500 per mile, exclusive of rolling stock, in ordinary country, and somewhat more in hilly country.

In the next place, the idea that the high percentage or good dividend earned is squeezed out by providing poor accommodation for all classes of passengers is a delusion. The third-class carriages on Indian railways are no whit inferior to those on the English suburban lines, such as the L. B. S. C. R. or L. C. D. R., or to those on the French railways, in which there are no cushions to the seats or back and no bunks for sleeping. The first-class and second-class carriages on Indian railways, though not so handsomely upholstered or elaborately fitted up as those on the "heavy" English lines, are quite equal to the carriages of the above-mentioned companies. The seats always have cushions, and each passenger can have a berth or bunk for sleeping during the night. Lavatory arrangements with conveniences are invariably provided for the upper classes, and are also being gradually introduced on the third-class carriages. When, however, one reflects that the first-class fare in India is only slightly higher than the third-class in England,—namely, 1¼d. per mile,—while the third-class in India varies from ⅜*d.* to ½d. per mile, it must be admitted that passengers are most unreasonable if they complain that their comforts are not being duly attended to, or if they expect panelled photographs to while away the tedium of a long journey. Even these luxuries, however, may come in time. Surely cane-bottomed seats without cushions during the day are cooler and more comfortable in the warm season.

There is one point to which attention might be drawn here,—namely, that during festivals (*melas*) and pilgrimages third-class passengers often have to be transported in low-sided wagons with a tarpaulin or corrugated iron roof over their heads, herded like cattle, because none of the railways have sufficient rolling stock to cope with extraordinary rushes of traffic. To counterbalance these inconveniences the fares are further reduced, to say, one farthing, or even less, per mile. The modern pilgrim travels with far greater comfort and at far less expense than his fathers did before him; in fact, a pilgrimage in these days is reduced to a pleasant outing or a picnic, instead of being a severe penance.

TYPES OF LOCOMOTIVES, 1854–1897. EAST INDIAN RAILWAY.
By permission of Indian and Eastern Engineer.

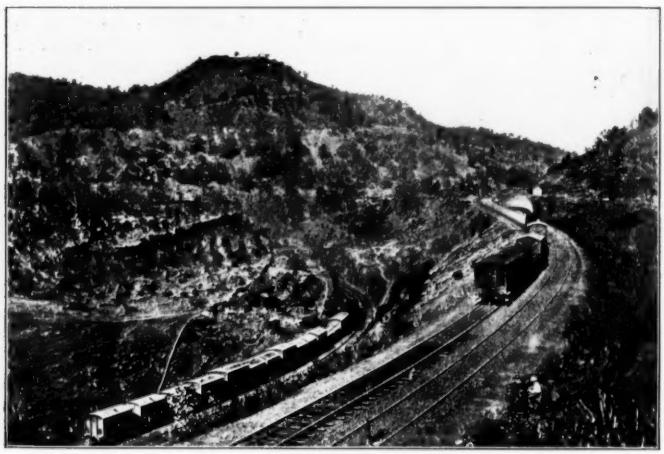
BORI BANDAR STATION, BOMBAY.
The Victoria Terminus of the Great Indian Peninsular Railway.

In the building of Indian railways the specifications seem to have been more rigidly adhered to than is usual in England. The writer has observed, in the building of railway bridges and stations in the suburbs of London and elsewhere, the use of a quality of bricks and lime which would not have been permitted in similar works in India. If such materials had been put in during the absence of the assistant or executive engineer, the structures would have been condemned and pulled down by order of the chief engineer or the government inspector, and the subordinate, or clerk of works, and engineer-in-charge, would have been severely reprimanded for neglect of duty.

The procedure adopted in the construction, maintenance, and management of Indian railways, though modelled after English practices, differs in many details from the practice usually adopted in western countries where labour has a high value. For example, earth work is done by baskets, trucks and wagons only occasionally being employed, and the banks being made from side trenches or borrow pits, while the stuff from cuttings is bad for one hundred yards and the remainder thrown to form spoil banks. In brick work or masonry the practice is much the same, curved-wing walls being seldom used. In roofing buildings many different methods are employed, according to the cus-

toms of the country. Thus there is the Sind roofing, made without scantlings, of hollow, slightly-tapered hexagonal tiles eight inches in length, and there are hemispherical domes on the Rajputana-Malwa Railway, formed of concentric rings in horizontal courses and built without any scaffolding. But the most usual roof is the flat or terraced one, of mud or fine concrete on battens and boarding, or on corrugated iron sheets. Here mention might be made of small staff quarters being roofed by hollow earthenware water pots, called "gharas," supported on old bull-headed rails in imitation of similar structures used by the Romans, of which ruins may be seen in the vicinity of Rome. Again, because of the military occupation of the country, certain peculiar features are found toward the northwest and northeast frontiers; thus the Lahore railway station has circular turrets, loopholed to protect the besieged. The tunnels on the Muckaf Bolum and the Sind-Pishin are crenelated with machicolations, so that they may be defended against the attacks of an enemy. Lastly, in all the large Punjab bridges the abutment is made extra wide, and within the space so formed is provided a well-hole with a pump, so that the defenders may not be starved out and need not expose themselves when getting water during a state of siege.

We may now enquire into the causes of the success of Indian railways, making them a model for the whole world to copy. It may be alleged that the African railways pay 8 per cent.; true, but only

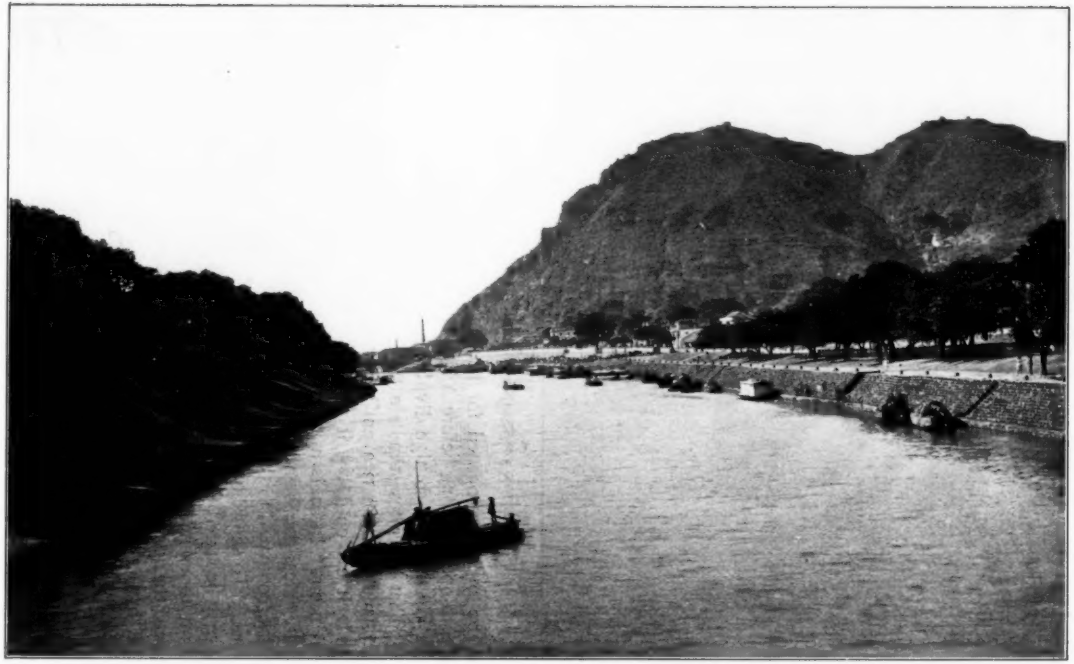


REVERSING STATION, BHORE GHAT.
Great Indian Peninsular Railway.

PORTION OF KISTNA BRIDGE, BEZWADA (MADRAS).

2,200 miles are opened for traffic, while India has ten times that length open. Long before Africa has 20,000 miles open, the directors will find that so high dividends cannot be paid regularly.

That low rates stimulate traffic is a fact that was not known in England and America until keen competition with foreign produce made it evident; but it was foreseen by Indian administrators and engineers. India is a poor country, and it was clearly understood that, unless goods and passengers could be carried at abnormally low rates, compared to those in England, there would be no traffic of any kind. To show how alive the native merchants are to cost of carriage, it may be stated that the Madras railway yearly loses the carriage of many thousands of tons of grain because the alignment has not followed the usual trade routes and the stations are not conveniently near the towns. Another case, which came under the writer's notice so recently as 1888, while he was resident engineer, may be mentioned. Leiah and Multan are two large grain centres, being joined by a road crossing the deserts of Sind-Sagar. The railway makes a slight detour to get a good crossing of the Chenab river. While this large bridge was being built, the railway was open to traffic, but the traders were charged a small ferry fee, with the result that the road was util-



CANAL VIEW, BEZWADA (MADRAS).

ised in preference to the railway. Immediately the ferry fee was removed, the grain traffic came back to the railway.

As a proof that even experienced men may be mistaken or take too pessimistic a view, it may be stated that in 1880, when the Rajputana-Malwa railway was opened, it was believed that one goods train and one mixed train each way would be sufficient for all purposes. Strange to say, from the commencement six trains each way were required; then nine; and so on, until as many as forty trains were run on this single track. Even now the stations and goods sheds are often choked with grain bags. The Rajputana-Malwa belongs to the Bombay-Baroda system, but the accounts are kept separately, and the returns show that 9 to 11 per cent. on the subscribed capital are the usual earnings. The writer feels a natural pride when he remembers that he was one of the engineers on two different sections, even though his life was threatened while he was engaged in the Serohi district.

There are five classes of goods, the lowest rates being charged for class 1. These rates vary from $\frac{1}{10}$ to $\frac{1}{5}$ of a pie per mile per maund ($82\frac{2}{7}$ pounds) or 4 to 27 pies per ton-mile. It is not easy to calculate the equivalent in English currency, as the rupee varies daily, but roughly speaking, the rates vary from $\frac{1}{3}$d. to $2\frac{1}{4}$d. per ton-mile,—no doubt considerably less than railway, or even canal, rates in England. In the latest Blue Book the principal commodities and the earnings therefrom on the standard and metre gauge lines for 1896 are given as follows:

Commodity.	Tons.	Earnings Rs value.
Grain and pulse	5,701,249	30,186,439
Coal and coke	4,505,758	13,498,668
Oil seeds	1,701,577	11,095,251
Salt	1,471,713	8,451,630
Jute	1,200,312	6,373,532
Sugar	1,161,703	7,602,137
Other articles of merchandise	1,978,171	12,386,668

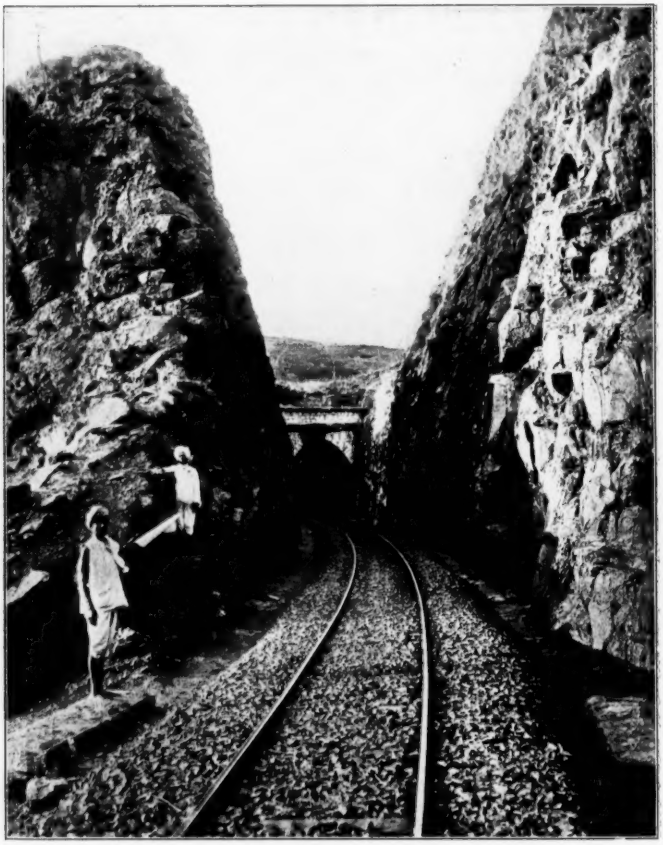
Besides these, there are cotton (raw and manufactured), metals, provisions, railway plant and rolling stock, timber, wool (raw and manufactured), liquors, drugs and chemicals, tobacco, paper, silk, and many other items. In every case the earnings of 1896 were less than those of 1895. Those of 1897 should show an increase, then, over those of 1896, and perhaps over those of 1895 also.

One of the most important factors in, if not *the* principal cause of, the financial success of Indian railways is no doubt the low rates at which land has been acquired. In some instances wealthy landowners have given the land free to the paramount power, having their

ONE SPAN OF THE SUKKUR BRIDGE.
North Western Railway.

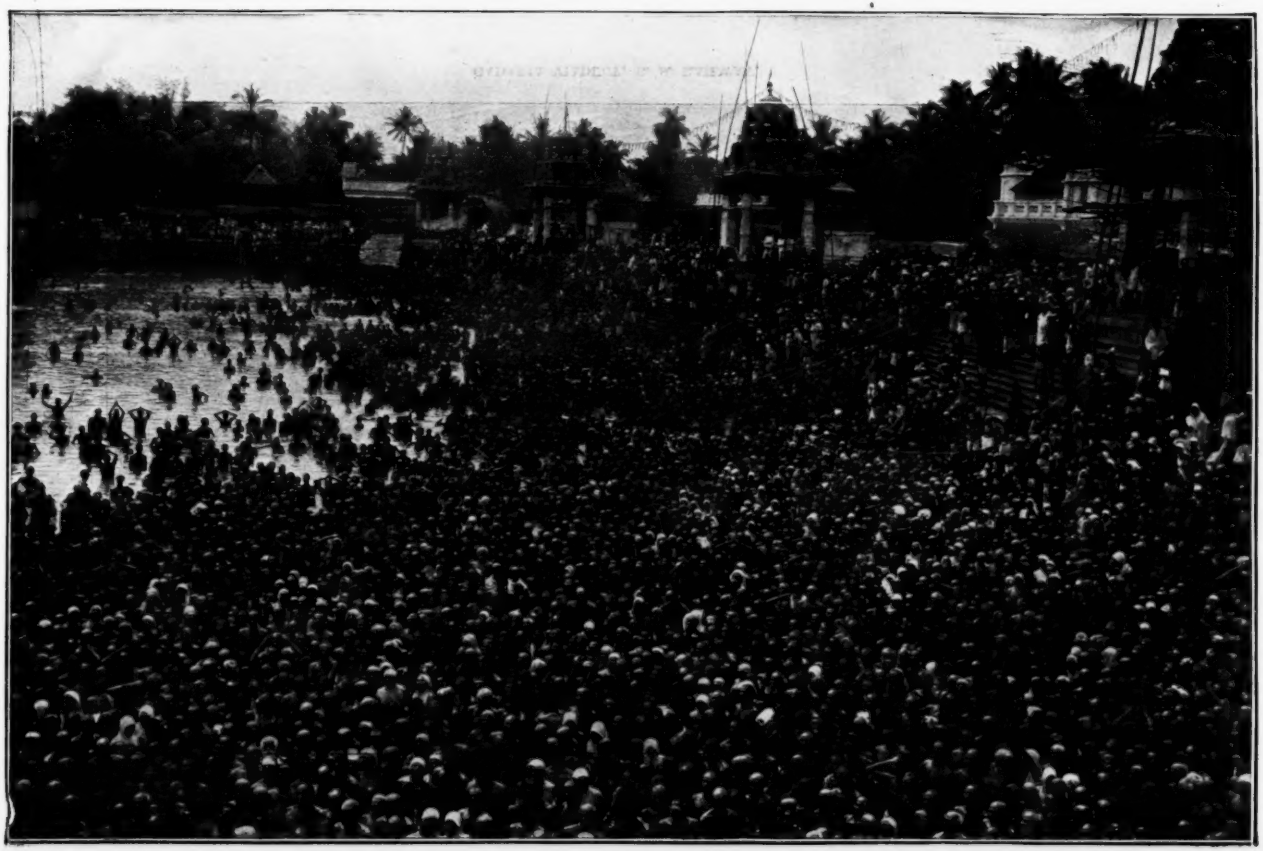
names published in the *Gazette* of India as public benefactors. In other cases waste lands have been obtained at merely nominal rates. In no case, I believe, has even irrigated land in the districts been assessed at a higher value than £50 an acre, and most of the land has

LAHORE STATION, NORTH WESTERN RAILWAY.
Showing turrets and loopholes.

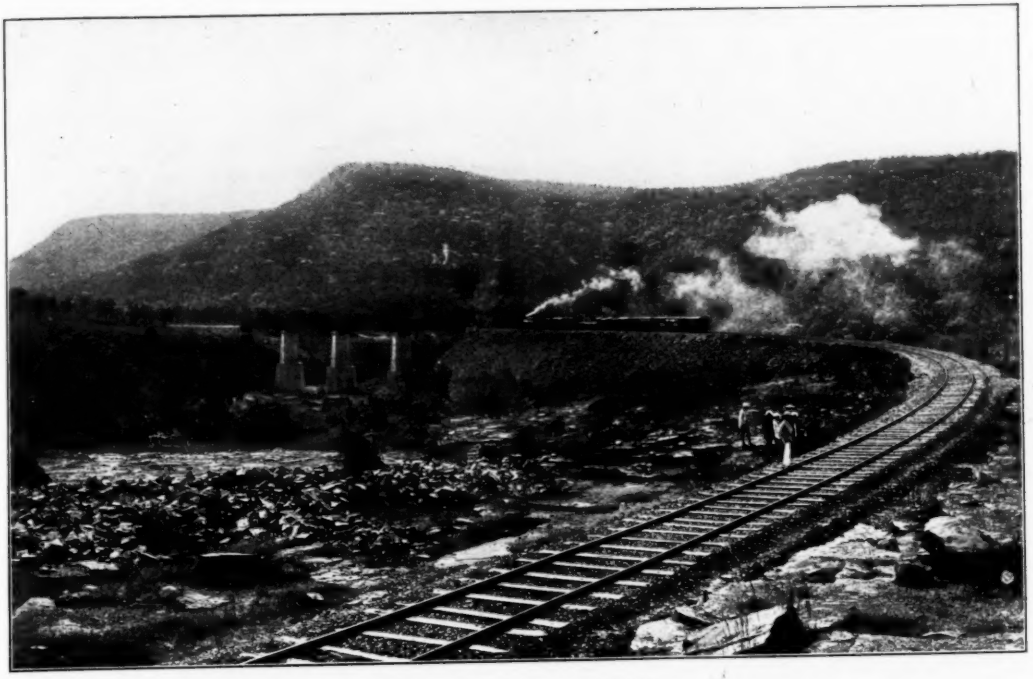


TUNNEL NO. 3, HOLKAR STATE RAILWAY.
View of Down Face, Showing Deep Cutting.

been paid for at rates running from £10 to £40 per acre. It is possible that near the Presidency towns a few acres were paid for at higher rates, say, even £200 per acre. When, however, one compares the above rates with the prices paid in England and America, one cannot be surprised that English railways are over-capitalized to the tune, it is said, of fifty millions sterling. Another factor of no mean importance is that no money has been wasted in exploiting schemes, paying concessions, or contesting rival plans before parlia



PILGRIMS BATHING IN THE SACRED TANK; SHOWING CROWDS HANDLED BY INDIAN RAILWAYS.



GADARIA VIADUCT, B. S. RAILWAY.

mentary committees, all of which processes run away with immense sums of money. The government of India orders a survey to be made, and the matter is gazetted, so that all concerned may know; the survey is, as a rule, carried out, without molestation of any kind, by a regular staff. If funds can be allotted, a special land commissioner is appointed to take over the land, the engineers meanwhile entering on the land and commencing operations. Take the case of the Rewari-Ferospur line, 90 miles in length from Rewari to Hissar. This was surveyed by two parties from March to May, 1881. The estimates and plans were prepared, and construction commenced in October, 1881, the line being opened for traffic in June, 1883,—within two years from the time the first orders were issued. The country traversed was easy; still, in what other civilized and populous country could ninety miles of railroad be surveyed and constructed in two years? The prairies of Central America cannot be compared, for here were no vested interests, few settlements or claimants, and probably no rivers or difficulties of any kind.

Another important cause of the cheaper construction of Indian railways is the cheapness of Indian labour. In Burma and Baluchistan unskilled labour gets one shilling a day, and skilled labour half-a-crown, while in most parts of India ordinary labourers get sixpence, and excellent masons and carpenters can be obtained for eighteen pence, a day. There are no trade unions in India; still, strikes are by no means uncommon, as every engineer knows. If the contractor will not pay his labour regularly, they refuse to come to work, and the engineer has to act the part of the board of trade and put in force an act of conciliation, though the particular act was never passed by parliament. During harvest time labour often cannot be obtained for love or money, while religious festivals and marriage ceremonies frequently draw away men at most inopportune moments. The English labourer is troublesome in his way, but the English contractor has not to contend against superstition of a most ghastly kind. Suppose a bridge is being constructed over a sacred river, and an accident occurs; nothing will induce the gangs to resume work till goats, kids, calves, or other sacrifices have been made, and it is generally rumoured that, to propitiate the deity, a few virgins should be immolated. This is no sentimental story; such a thing has occurred within the experience of many engineers.

Every country has to acquire its experience in methods of doing work. We have seen that no money was wasted in acquiring land or fighting rival schemes; yet time and money have been wasted in other ways. During 1871–1874 it was found that the standard gauge from Lahore to Kurachi was costing too much, and it was proposed

to introduce the narrow gauge between Multan and Kotei, thus making two breaks in gauge in about 850 miles. This "battle of the gauges" was fought out at the Institution of Civil Engineers, and, through the influence of that body with the marquis of Salisbury, the attempt at cheapness was frustrated; otherwise the development of the port of Kurachi would have been delayed many years.

There is another cause which helps to swell earnings,—the pilgrim traffic. If the crop is a bumper one, the grain comes in so rapidly that the stations and goods sheds are blocked with bags of grain, especially during March and April. Before the grain has been completely cleared, the pilgrim traffic begins,—in May, just after the harvest has been gathered; the cultivators then feel that they have earned a holiday till June 15, when the rains may be expected. This pilgrim traffic is getting heavier every year, for more people travel now than ever before. Notwithstanding the famine, 7,750,000 more passengers were booked during 1896 than in 1895, though the tonnage of goods was slightly less than before. As in all countries, so in India, the railways suffer from slack periods, when the rolling stock suffices; but, as a rule, there is complaint that in busy periods the Indian railways are very deficient in rolling stock.

The following are some of the projects which are at present attracting the attention of professional men and merchants. (A) The Visagapatam-Raipur railway, to connect the port of Visagapatam with Raipur in the central provinces. This route was surveyed fifteen years ago, and is being commenced as a famine work, but will open immense tracts of country, some fertile, some waste with minerals. (B) The Calcutta-Karachi through route across India. *Indian Engineering* says: "Marover junction to Kotah and Goona to Jhansi are not in the schedule of lines under survey or projected, but it is to be hoped that they will be included in this year's programme. The line from Shadipalli to Balotra, now in progress, completes the chain." (C) The development of the Damuda Valley coal-fields, which have been unnecessarily delayed, simply because the country to be traversed is somewhat difficult. The problem of the future supply of fuel for locomotives has long exercised the minds of engineers; yet sanction cannot be obtained for this important scheme. (D) The Delhi-Kotri line through the deserts of Bi kanir. The chief difficulties to overcome are sand ridges three hundred feet in height, and want of water; but, if land is to be found for India's teeming millions, this problem must be attacked. Reconnaissances and levels are available. (E) The Benares-Puri scheme, surveyed some twelve years ago and then dropped. Any company taking up this scheme will find it a remunerative one, as it joins two places of pilgrimages containing holy

shrines. (F) The through connection between Burma and Assam. Three routes have been surveyed by Mr. R. A. Way, chief engineer, who suggests the most northern one; but the project hangs fire from lack of funds.

In addition to the above there are at least one hundred and fifty projects available in the public works secretariat of the government of India. In April, 1895, the writer read a paper before the Society of Arts on "The Coming Railways of India and Their Prospects." The majority of the railway projects he then suggested have either been taken up already, or are being proposed.

The Indian railways are classified into five divisions: (1) State lines worked by companies; (2) State lines worked by the State; (3) lines worked by guaranteed companies; (4) lines owned by native States and worked by a company; (5) assisted companies. One should always bear in mind that, on account of the military tenure of the country, there are also two great classes,—namely, military lines, built almost exclusively for the defences of the empire, which are unremunerative, and commercial lines, intended to develop the resources of the country.

Due to financial pressure, wars, and the contrary opinions held by different men in authority, the railway policy of the government of India has been a vacillatory one from the beginning. It is sufficient to point to the latest case. Two years ago a railway programme was drawn up by Lord Elgin, when it was proposed to allot five crores of rupees per annum for five years for the construction of railways alone; but what do we find? On account of the frontier troubles this allotment has already been halved, and further curtailments no doubt will be shortly ordered. Of course in such a case one cannot blame the government of India. Unfortunately, however, this causes not only waste of time, but—what is worse—a want of confidence in the minds of contractors and others, who are suddenly ordered to stop their works, though they have completed their arrangements for prosecuting them with vigour. The most serious charge, however, levelled against the government of India by the press seems to be this—that, while it professes to encourage private enterprise, every obstacle seems to be placed in the way of those desirous of obtaining concessions. Thus Mr. Calthorpe, in a paper read before the Society of Arts, states that his company offered to construct and maintain the Barsi light railway without a guarantee; yet it took eight years to obtain the concession, with two special visits to India and an expenditure of three thousand pounds. No doubt there are many applications for concessions, some of them "bogus," so that careful enquiries have to be made and securities exacted that the concession-

aires intend to do the work directly themselves, and will not dispose of their grant to someone else. The British public, or, rather, financiers, have become so accustomed to a guaranteed rate of interest that it is not easy to get even a hearing, unless this condition has been granted. Therefore the government should be more liberal, relaxing the rules when any respectable firm comes forward with a proposal to construct feeders without any guarantee at all.

The government of India is so dreadfully afraid of debt that it desires to build its railways out of surplus revenue. Now, no country in the world ever undertakes productive public works except by borrowed capital; moreover, the debt incurred for railways and canals in India is so small—a few millions—that this debt might easily be doubled without fear of disaster. The great bugbear is, of course, the constantly changing value of the rupee, which has caused the secretary of State for India to resolve that in future all proposals must be in rupee capital,—a thorn in the side of the London money-lender, who prefers his interest in sterling.

In addition to the difference between western and eastern practice in construction, maintenance, and management, there is a remarkable difference in policy. The Indian press is constantly clamouring for encouragement of private enterprise; so the government gave over the East Indian and Rajputana-Malwa railways to be worked by companies,—a singularly weak attempt at economy, as these two are the best paying lines in the whole country. On the other hand, political agitators in England are beginning to clamour for the nationalisation of British railways. This is not likely to take place, as no ministry dare face the expense, but, even if the transfer could be effected, the public would soon regret the bargain, for State management is not nearly as progressive as private enterprise.

DILUTION PROCESS OF SEWAGE DISPOSAL.

By Rudolph Hering.

THE waste water of cities, or what is called sewage, contains ingredients which may become objectionable in two ways.

The most dangerous ingredients are those which can affect the health of human beings. These are the disease-producing bacteria which enter the sewage, for instance, through intestinal discharges or through laundry water, when clothes worn by sick persons have been washed therein. When such bacteria find their way into the air or into drinking water, a propagation of the specific disease is thereby invited.

During the last twenty years bacteriology has shown that many, and probably all, of the so called zymotic diseases are caused by germs which are transported by air or water. It has also been demonstrated that many cases of illness and death can be prevented by a careful and proper disposal of the sewage.

Some of the pathogenic bacteria perish rapidly, after they leave the body and have been taken up by the sewage, but others persist to a remarkable degree. We have evidence that the typhoid bacillus survives after the sewage which contained it has been converted into practically clear water, and even after such water has been frozen for several weeks. We must therefore seek to destroy these pathogenic bacteria, or remove them in as thorough a manner as practicable.

The other way in which sewage becomes objectionable to a community is by its offensiveness. This is produced by the development and diffusion of gases which are the results of a rapid decomposition or putrefaction.

The sewage pollution, dangerous to health can be ascertained by a chemical analysis, by an inspection of the watershed, and principally by a bacterial analysis. The pollution which is objected to merely on account of its offensiveness can be measured by a chemical analysis alone.

In a proper system of sewage disposal, therefore, the main object is to destroy disease bacteria, or at least render them harmless, and the secondary object is to prevent putrefaction or offensiveness.

It is the engineer's duty, when designing the works, to prevent these objectionable results, and to provide satisfactory conditions at the least possible cost.

It was formerly held that the disposal of sewage was really an agricultural question,—that a city's manurial refuse had a high money

value, and that it should be returned to the earth whence it came. In Europe this opinion prevailed for many years, and is still occasionally defended on grounds of political economy. But now another point of view has forced itself into recognition, and has generally carried the day. It brings into the foreground the cost of the method of disposal. If the expense of returning sewage to the soil is greater than that of using other manures of equal value, then sewage utilization, says the modern economist, is no gain to the community. It will be better to let the matter go to waste. Pure gold exists in many of our rivers. But in most cases it would cost more to extract it and render it useful to the community than it is worth. Therefore it is economy to let this precious metal remain where it is.

We can choose between several practical ways of treating sewage, according to the necessities of the case.

If the foul water or sewage of a community is liable to enter a stream whence water is taken for drinking purposes, it is imperative to purify the water or the sewage. Whenever the stream is not subsequently used for a water-supply, such a purification may not be required, and it is necessary simply to prevent a nuisance.

The present article deals with the latter class of cases, where a water-supply cannot be injured by the introduction of sewage into a stream, where it is merely necessary to prevent offensiveness, and where the sewage can be left to gradually and completely disappear in unassisted natural ways.

It is impossible to prevent all disease germs from getting into a water course. We can guard it only against a serious pollution. We cannot prevent rain from washing the streets, the fields, the forests, and discharging this cleansing medium into the streams. And along with this water must go the dust of the air, and the myriads of bacteria sometimes contained in the same. There must go with it parts of the intestinal discharges of animals, birds, and insects, and parts of the manure with which the fields are covered. Unquestionably much injurious matter is carried into the water courses by the rain water, and we cannot prevent it.

We are therefore obliged to seek safety in another direction,—namely, in the filtration or purification of all water-supplies immediately before the water is used. How clearly this conclusion is recognized we can see in some cases in Europe, where, although the water comes from uninhabited mountain districts and is apparently pure, provisions are made for its filtration before it is furnished to the inhabitants for domestic use.

Disposal of the sewage of a city by dilution in a river is still very common, and we are even forced to acknowledge that it will remain

so for a long time. In Europe we find cities situated on some of the larger rivers, discharging their sewage into them with entire impunity, provided certain governmental restrictions are followed. In our country we have cities along the Mississippi, Missouri, Ohio, and Delaware rivers, discharging their sewage into these water courses without causing any offence. Such a disposal attracts unfavorable attention only when the water is subsequently used as a domestic supply.

We find, further, that the cities on our great lakes discharge the sewage into their waters, and dispose of it finally by dilution, while deriving their water from the same lakes. No doubt the question here is likely to become a serious one, and it is highly probable that, in the future, unless the sewage outfalls and water intakes can be kept sufficiently well separated, either a treatment of the sewage before its discharge, or a purification of the water-supply, or perhaps both, will be required.

Various authoritative statements have been made regarding the permissible addition of sewage to streams in order to prevent objectionable conditions. About the year 1867 a statement was made by Dr. Letheby and others in England that, if the sewage is diluted to at least twenty times its volume, it will not only be made inoffensive, but be thoroughly destroyed after flowing a "dozen miles or so." The rivers pollution commission of Great Britain, in 1878, maintained that no river in England was long enough to allow of a complete disappearance of sewage matter discharged into it.

Dr. Fleck (Ueber Flussverunreinigung. Jahresbericht der Kgl. chem. Centralstelle, Dresden, 1884), after an extensive inquiry into the subject in Germany, expresses the opinion that water is to be considered objectionable if in 100,000 parts there are contained more than 1 part of organic matter and more than 0.01 part of ammonia.

Some years ago, when engaged in solving the difficulties of sewage disposal for Chicago, the writer found that the problem could be most economically solved by adopting a somewhat unusual plan of sewage disposal. A canal was recommended to be built, leading from Lake Michigan to the Illinois river, a branch of the Mississippi. Into this canal the sewage of Chicago, diluted with a sufficient quantity of water from Lake Michigan, was to be discharged, that it might flow by gravity into the Mississippi river. Incidentally this project had the economical advantage of establishing a water way for large boats between the lakes and the Gulf of Mexico. The project was adopted on these merits, and its execution is now almost complete. An artificial purification of the sewage and a return of the effluent water into Lake Michigan had been found to be more expensive than the proposed scheme, and also less advantageous to the community.

The necessity for constructing an artificial channel of very large size and great length necessitated a most careful inquiry into the proper degree of dilution that should be given to the sewage to make it inoffensive and in all respects unobjectionable in the canal and the rivers of the Mississippi valley. Whatever information could throw light on this subject was collected from Europe and from this country. The conclusion was that a flow of four cubic feet per second should be provided for the sewage of every thousand persons. Since then confirmative information has been collected, and to-day the presentation of the problem of sewage dilution is not beset with as many difficulties as formerly. A safer opinion may be reached regarding necessary conditions.

The first point to settle was the unit of measure of permissible pollution. Inasmuch as the water consumption per head of population varies so greatly in different cities, and as the quantity of water thus used ultimately represents the quantity of sewage, the latter is a very indefinite unit. The writer therefore suggested ("Notes on Pollution of Streams," Vol. XIII of the American Public Health Association, 1888) that the unit be the average pollution caused by one thousand persons. The quantity of refuse per inhabitant does not vary much, and thus the average becomes a satisfactory measure. Where a large amount of industrial refuse is discharged into rivers, a special allowance must, of course, be made therefor.

The second point to settle was the standard of inoffensiveness. As this can be measured only by personal judgment, it cannot be exact. But if the water is to be used for manufacturing purposes, it is possible to be more accurate. As some mills may require a higher standard than others and a particular kind of purity, the effect upon the particular industry may be readily ascertained.

A standard for the prevention of destruction of, or injury to, fish is again more difficult to fix, as it depends on the particular species which it is desired to retain. Some fish and crustacea apparently live and thrive in sewage-polluted water. Others die where there is but a slight pollution. Some fish are killed where the sewage flow is concentrated, but live when the same sewage has been dispersed in the stream. Oysters have been so infected by sewage-polluted salt water as to propagate typhoid fever.

While it is possible thus to throw some light on the requirements for a safe sewage discharge into streams, each case, nevertheless, requires special examination, and no specific rules can be set down which are applicable to all cases.

There are several ways in which we may determine the least number of cubic feet of water required to cause the sewage from one

thousand persons to be inoffensive. In the first place, it is possible to obtain a sample of the sewage in its most concentrated state and mix it with enough water to make it unobjectionable, and thus determine the required dilution. This method is somewhat crude.

Secondly, it is possible to observe the gradual increase of pollution in a water course by successive discharges from a number of sewers, and, after determining the point at which the condition of the river becomes objectionable, to measure the flow of the stream at that point. Then, knowing the number of people whose sewage enters the stream, it is easy to find the desired measure of permissible pollution. Such information is available from a number of cities in Europe and America.

Thirdly, in a comparison with known cases, we may determine the number of people who can use a given stream for sewerage purposes without making it offensive, by the amount of free ammonia brought into the river with the sewage. This method is often the safest one, particularly where a stream is already somewhat polluted before it reaches a town which is to add more sewage to it. The composition of the water of the stream is first ascertained, and then, by calculation, it can be found what number of people will, by their additional sewage, produce the greatest pollution permissible.

The Massachusetts State Board of Health has made some investigations with this method ("The Pollution and Self-Purification of Streams," F. P. Stearns, 1890). By averaging the observations in several cities, it finds that the following standard amounts of each of the constituents contributed daily per inhabitant are required to change water into sewage.

Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
.015 pounds.	.003 pounds.	.218 pounds.	.042 pounds.

With these figures as a basis, the table given on the opposite page was prepared, which substantially accords with the information published by the board. No consideration is given to the analysis of the natural water flowing in the stream.

In using the table, it is generally sufficient to ascertain the free ammonia, which is a characteristic feature of sewage pollution, although by no means an unfailing index of offensiveness, which also other conditions may affect.

From what has been said, and from what will be said further on, it may be seen that a definite answer to the question of permissible pollution must rest upon a special investigation in each case. Nevertheless it is practicable to state certain general limits. In the above table the authorities of the State board of health have drawn two lines between which lies doubtful ground. If the flow of a stream is

CALCULATED COMPOSITION OF SEWAGE OF DIFFERENT DEGREES OF DILUTION IN A RUNNING STREAM.

Flowing Water.		Ammonia.		Dissolved Solids.	Chloride.	Remarks.
Cubic feet per second per 1000 persons.	Gallons per Capita per day.	Free.	Albuminoid.			
		(In parts per 100,000.)				
0.062	40	4.50	.90	65.4	12.6	Dilution is offensive.
0.077	50	3.60	.72	52.3	10.1	
0.093	60	3.00	.60	45.3	8.4	
0.108	70	2.57	.52	37.4	7.2	
0.124	80	2.25	.45	32.7	6.3	
0.140	90	2.00	.40	29.1	5.6	
0.155	100	1.80	.36	26.2	5.0	
0.186	120	1.50	.30	21.8	4.2	
0.232	150	1.20	.24	17.4	3.4	
0.310	200	.90	.18	13.1	2.5	
0.388	250	.72	.14	10.5	2.0	
0.465	300	.60	.12	8.7	1.7	
0 5	323	.5580	.1114	8.10	1.56	
1.0	646	.2790	.0557	4.05	.78	
1.5	969	.1860	.0371	2.70	.52	
2.0	1,292	.1395	.0278	2.02	.39	
2.5	1,615	.1116	.0223	1.62	.31	
3.0	1,938	.0930	.0186	1.35	.26	
4.0	2,584	.0697	.0139	1.01	.19	
5.0	3,230	.0558	.0111	0.81	.16	
6.0	3,876	.0465	.0093	0.67	.13	
7.0	5,522	.0399	.0080	0.58	.11	
8.0	5,168	.0349	.0070	0.51	.10	Dilution is not offensive.
9.0	5,814	.0310	.0062	0.45	.09	
10.0	6,463	.0279	.0056	0.40	.08	
15.0	9,694	.0186	.0037	0.27	.05	
20.0	12,926	.0139	.0028	0.20	.04	
30.0	19,389	.0093	.0019	0.13	.03	
40.0	25,852	.0070	.0014	0.10	.02	
50.0	32,315	.0056	.0011	0.08	.02	
100.0	64,630	.0028	.0006	0.04	.01	

less than two and one-half cubic feet per second per thousand persons discharging sewage into the same, an offence is almost sure to arise. When the flow is greater than seven cubic feet per thousand persons, offensive conditions are not likely to result. In other words, when the free ammonia contained in the water is greater than 0.1116, the conditions will probably be objectionable, and, if it is less than 0.0399, it is not likely that the sewage in the water will be noticed.

Within these limits judgment is required in order to select a

proper figure, and in forming judgment several other points should be considered.

The effects of mill-ponds may be serious in a sewage-polluted stream. By the reduction of the velocity, even when the pollution is slight, solid particles of the sewage will deposit, accumulate, putrefy, and give off offensive gases. Likewise, fluctuation of the water in a small polluted stream used for power purposes has a deleterious effect. If areas covered with water are uncovered when the water is drawn down, it is to be expected that putrefying sewage particles will at times be exposed to the air, and, if these are sufficient in quantity, offensive odors will be caused by the deposit. In such cases a greater dilution is required than when the flow is more constant and rapid.

When sewage is discharged into a tidal stream, or into salt water, other difficulties arise. Besides the deposits caused by a usual reduction in the velocity of flow, the effect of salt water retards the process of decomposition, and a larger dilution is necessary to prevent objectionable results than is necessary when sewage is discharged into fresh water under otherwise similar conditions.

The effects of temperature, too, may be of some importance when disposing of sewage by dilution. An increase of temperature produces a more rapid decomposition; the oxygen in the water is more quickly absorbed; and, if it is insufficient in quantity, putrefactive processes will prevail, and produce a nuisance. If the water is cold, the process of decomposition is slower; the oxygen contained in the water is used up less rapidly, and can be replenished from the atmosphere in some cases quite as fast; and a nuisance is less likely to result. At Duluth the low temperature of the water of Lake Superior has a marked beneficial effect upon the discharge of sewage into the same, so far as the rendering of a nuisance is concerned.

The effect of aeration is likewise important. When a stream descends rapidly, and especially when it falls precipitously over dams, the facility for aeration is increased, and a more rapid oxidation takes place. A stream having a steep profile can receive more sewage per unit than a stream in which the fall is slight.

When considering the effect of dilution, it must not be overlooked that the above table presupposes a thorough dispersion of the sewage throughout the water. It is necessary, therefore, in a given case, to consider the distance that must be traveled by the sewage before a complete dispersion is obtained.

It must also be understood that the flow of the stream, as given in the table, is supposed to be its minimum flow, which usually takes place in this latitude during the early autumn. At other seasons the

conditions will be better than those indicated, in proportion as the quantity of flow is greater.

When sewage is discharged into a tidal stream, it is diluted only by the fresh-water flow from the watershed, which flow alone should be considered. The tidal oscillation, however, while not assisting the dilution, will hasten the dispersion of the sewage. The rapidity of dispersion will vary with the local conditions, the currents, the velocity, and the specific gravity of the diluting water. The Boston sewage discharged into the ocean at Moon Island with the outgoing tide is lost to view after it has gone one and one-half miles.

There has been much speculation concerning the self-purification of sewage-polluted streams. No doubt such purification takes place in some degree, although it is often confounded with the much greater improvement caused by a natural increase of flow and therefore by a greater dilution. The actual self-purification is to be attributed partly to subsidence, partly to the oxidation of organic matter, and partly to the destruction of organic matter by small animals and plants.

The effects of these three causes are slight compared with the effect of dilution, but they are active, and they assist the desired process. Although every rain brings into the rivers large quantities of impurities, they gradually disappear, and the rivers regain their natural purity.

Subsidence has a marked influence in clarifying a river when the velocity of the water diminishes. Oxidation is a slower process, and is dependent mainly upon bacterial life and the conditions favorable to it.

Small animals and, to a less extent, plants assist the process under suitable conditions. Says Dr. Sorby (*Journal Royal Microscopical Society*, 1884, pp. 988, etc.): "Taking all the facts into consideration, it appears to me that the removal of impurities from rivers is more of a biological than a chemical question, and that in all discussions of the subject it is most important to consider the action of minute animals and plants which may be looked upon as being indirectly most powerful chemical agents." To get the best results from such animals and plants the sewage must be delivered fresh, as their action ceases after putrefaction has begun.

Sometimes, when sewage is discharged into a stream to be used for a water-supply, an artificial purification is not only desirable, but necessary; there are other cases, however, where it will better satisfy the interests of the community to give up the river to the reception of sewage. In other words, there are cities where it is more expensive to thoroughly purify the sewage than to obtain a pure water-

supply, either from another locality or by filtering the sewage-polluted river water.

We have an example of the latter case in the cities of Hamburg and Altona, in Germany. Here the sewage from a population of about one million inhabitants is discharged into the river Elbe. Yet the same river, under conditions allowing of a considerable pollution, is used as the source of water-supply for both cities. But the water is now subjected to so thorough a purification that it is doubtful whether disease which has its cause in the polluted raw river water is transmitted by it.

The disposal of sewage by dilution is therefore satisfactory in many places, the main conditions being that at all times the flow of the stream receiving the sewage shall be sufficiently copious to so disperse and dilute it as to prevent putrefaction and substitute oxidation. When sewage must enter a stream subsequently used for a water-supply, it better answers the demands of sanitation and economy to thoroughly purify the water-supply, and allow the sewage to enter the stream by which it is well diluted, than to purify the sewage, and, further down the river, allow its raw water to be supplied for domestic use.

THE CYANIDE PROCESS AS APPLIED ON THE RAND.

By W. Leonard Holms.

IN 1890 the African Gold Recovery Company introduced the cyanide process into the Witwatersrand. Many other methods for the treatment of tailings had been tried previously, with no very satisfactory results, and, in the opinion of the majority of mining men, the new process offered no greater prospect of success. As shown, however, by the experience of the past seven years, the cyanide process is the most important advance in gold metallurgy achieved since the Rand became a mining centre. This fact will be better appreciated when it is noted that not half-a-dozen mines in the Transvaal would to-day be working at a profit, if the tailings were left untreated. During 1897 the total output of gold on the Rand was 3,034,678 ounces, of which tailings treated by cyanide yielded 934-545 ounces, or 30½ per cent. of the whole return.

When the process was introduced, the capacity of the plants was very small, twenty tons of tailings a day being considered a large quantity to handle. The consumption of cyanide was exceedingly high, amounting in some instances to as much as three or four pounds per ton treated. The extraction was for the most part disappointingly low, and, when tailings began to be received direct from the battery, the percentage of leachable pulp recovered was comparatively small, probably, on an average, not more than 60 per cent. To-day there are few plants in operation which have a daily capacity of less than one hundred tons; several are capable of treating more than 450 tons; and at the Simmer & Jack Proprietary mines works have been built to handle more than 1,100 tons per diem. The average consumption of cyanide is, approximately, .66 pounds to .75 pounds per ton treated. The average extraction is 75 to 80 per cent., and the amount of treatable pulp recovered from battery tailings 70 to 78 per cent.

The cost of working varies with size of plant, natural facilities of location, etc., but the average cost per ton may be taken at 3s. 6d., which figure includes handling of tailings before and after treatment. Seven years ago the cost per ton was sometimes as much as thrice this amount. The chief factors in effecting this reduction in working expenses have been improvements in the construction of plant, decrease in the quantity and price of cyanide used, and increase in the quantities of tailings handled in individual plants.

It is impossible, in an article such as this, to detail the steps by

which the present perfected cyanide plant has been evolved, but a brief description of the type of plant and *modus operandi* generally adopted will not be out of place. On leaving the battery plates the tailings are connected by launder to the cyanide plant. Unless exceptional fall is afforded by the location of the latter, the pulp is raised by tailings pump or elevating wheel* to the required height above the vats. From the discharge point it flows through a series of spitzlüten, which eliminate the coarser sands and pyrites, amounting altogether to 10 or 15 per cent. of the total quantity treated in the works. The spitzlüten usually employed for this purpose are 4 inches by 2 inches by 3 feet 6 inches. The clear-water-supply to these should have a head of not more than 12 inches above the surface of the pulp in the spitzlüte; otherwise inconveniently small discharge-orifices must be used, or an altogether unnecessary amount of water employed. Nozzles less than ¾ of an inch in diameter are liable to choke, and are, therefore, objectionable. The balance of the pulp which passes through the spitzlüten flows thence into the collecting vats. There are two methods of filling the latter. The first is effected by means of a large base pipe, which is moved about the vat intermittently by a native, who distributes the sand as evenly as possible over the entire surface. In this case the excess of water carrying the "slimes," or clayey portion of the ore, escapes from the vat over a species of sluice-gate, which is raised periodically as the accumulating sand rises in the vat. The second is effected by means of a Butters & Mein's distributor. This apparatus consists of a flat, conical hopper revolving on a spindle, which is fixed on a column set in the centre of the vat. From the hopper radiate horizontally a number of pipes with bent ends. When the pulp is admitted into the hopper, it passes through the bent ends of the pipes, and imparts a rotating motion to the whole apparatus. As the pipes are of various lengths and diameters, an approximately equal distribution is obtained over a series of concentric circles. The water and slimes may be allowed to escape, as in the first method, or the vat may be filled with an annular launder, into which the water overflows as soon as it reaches the top of the vat. Whichever of these methods is adopted, it is usual to let the slime water pass through a small spitzkasten after leaving the vats, in order that any fine, but leachable, sands which have been carried over mechanically may have an opportunity of resettling. The discharge-pipes from the spitzkasten are connected with the feed to the tailings pump or elevating wheel, so that the recovered sands are again carried into the vats.

* Made of wood or iron, or a combination of both, and varying from 25 to 50 inches in diameter.

When the vat is completely filled with sands, it is allowed to stand for a period varying from twelve to twenty hours, according to its size and the leachability of its contents. During this time the water which it contains is drained off as completely as possible through the leaching pipe. Unless artificial suction is applied, the vat will still contain about 15 per cent. of moisture at the end of this operation. If the tailings are perfectly fresh and unoxidised, as is almost invariably the case, a very weak solution of cyanide—say, 0.02 per cent. —is pumped on, until the charge is completely saturated and covered. The sand being fed into the vat with water, it packs hard, and makes the percolation of the solution a difficult matter; thus sometimes several hours will elapse before the vat is completely saturated. For the same reason little or no gold is actually dissolved out in the collecting vat, as the interstices between the particles of sand are comparatively minute and do not readily permit an adequate quantity of air to pass down through the sand with the solution. The object, therefore, of putting on solution in these vats is not so much to dissolve gold as to thoroughly impregnate the whole mass with cyanide solution, which, on being subsequently brought freely into contact with the atmosphere, acts energetically on the gold contents. After the solution has stood for a few hours on the vat, it is drained off through the weak liquor precipitation boxes, and, when the moisture in the sands has been reduced, as before, to 15 per cent., the vat is ready to be discharged into the leaching vats. The latter are now usually erected immediately beneath the collecting vats, which are fitted with several bottom discharge doors,* so that the transferring of the sands from the one vat to the other is done at a minimum of expense and with the utmost dispatch. As the tailings fall through the space between the two vats, they are brought well into contact with the air, and, moreover, any lumps which may have been formed during deposition in the collecting vats are broken by the fall and thereby rendered leachable. The contents of the leaching vats are, therefore, in every way better fitted for treatment than when they were in the collecting vats. The interstices between the sands are much larger, as may be judged from the fact that the cubic capacity of the leaching vats has to be some 20 per cent. greater than that of the collecting vats; therefore, free admission of air and uniform leaching are attained. As soon as the sands have been transferred, they are levelled off, and a medium cyanide solution (about 0.35 per cent.) is pumped on, until there is sufficient to displace the previous weak solution and saturate the mass thoroughly. This solution is

* Originally introduced by Mr. Charles Butters.

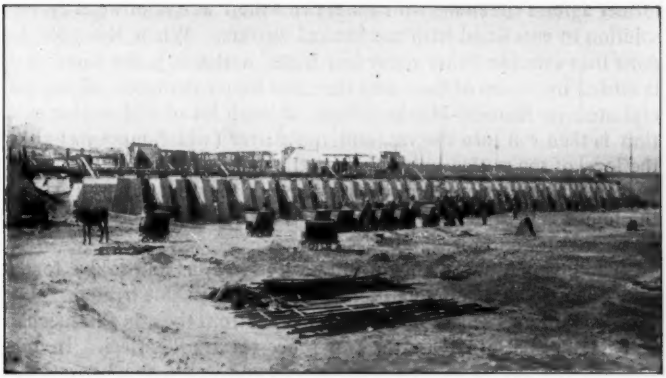
allowed to percolate slowly through the tailings, and a couple of hours after it has disappeared from the top of the vat a strong cyanide solution (0.10 to 0.08 per cent.) is pumped on. This strong solution is kept continuously percolating, fresh quantities being pumped on periodically, as required. It is necessary, however, to allow an hour or two to elapse between the time that the tailings are uncovered and the next pumping, in order that a sufficient supply of air may be drawn down by the descending solution. When sufficiently strong solution treatment has been given, medium solution is pumped on, followed by weak solution, the quantities in each case being so calculated as to to thoroughly displace the liquor previously occupying the vat. If the state of the solution storage vats will admit, a final water wash is given to displace the solution last put on; but, as this is not practicable, as a rule, the vat is usually drained as dry as possible and discharged, the sands containing about 15 per cent. of the weakest solution. As this solution rarely assays more than ten grains of gold per ton, the tailings are enriched thereby to the extent of only 150 grains per ton. The discharging of the vats is accomplished through bottom discharge doors into 20 cubic feet trucks, which pass under the vats through passages left in their foundations. When full, the trucks are run out on a gradient to an endless rope tramway, on which they are hauled up to the residue dump and tipped. From the commencement of treatment in the collecting vats to the time of final discharging about 130 tons of solution of all strengths are used for every 100 tons of sands, and the total time so occupied is about four and one-half days.

The pyritic product obtained from the spitzlüten, as described above, is treated much as are the ordinary sands, but the time occupied and the amount of strong solution used are very considerably increased. From eight to twenty days may be required to obtain a satisfactory extraction, and the amount of strong solution employed may be three or four times as much as in the case of the sands. The collecting vats are much more freely employed for cyanide treatment when the spitzlüten products are dealt with, as the latter contain practically no slimes or fine sands, and are thus not liable to pack hard, but, on the contrary, afford a very good uniform filtering medium. For this reason strong solution treatment is commenced in the collecting vat, and the precise time at which its contents are to be transferred to the leaching vat is determined merely by convenience.

The precipitation of the gold is effected either on zinc shavings or by the Siemens-Halske process. Both of these methods have been so often described that it is unnecessary to explain them minutely. In the zinc process the solution passes upward through a succession of

compartments containing zinc shavings resting on a movable tray formed of coarse screening. The gold is thrown down as a fine powder, and replaced in the solution by zinc. In the Siemens-Halske process the solution flows through compartments very similar to those of the zinc box, but the zinc shavings are here replaced by lead strips or shavings hung between iron plates placed vertically and in the direction of the length of the box, about 4½ inches apart. The lead strips are connected with the negative, and the iron plates with the positive pole of a dynamo, and the solution is thus electrolytically decomposed, the gold being plated on the lead cathode. The iron plates are wrapped in canvas, to prevent short circuiting. The current employed is from 250 to 300 amperes, which gives a current density of about 0.06 ampere per square foot of cathode. The standard size of precipitation box is 32 feet by 5 feet by 5 feet, and is divided into twelve compartments, in each of which are thirteen iron plates 26 inches by 48 inches by $\frac{3}{16}$ of an inch wide. The lead strips are about 1½ inches wide, cut from sheets weighing 0.15 pounds per square foot. The rate at which the solution flows through such a box is about three tons an hour. The zinc process has the advantage of being less expensive to install than the Siemens-Halske, and is simpler to work, while the clean-up of the gold is an easier operation. The Siemens-Halske process has, however, an almost inestimable advantage over the zinc method in its power of precipitating gold from the very weakest solutions of cyanide; the zinc shavings are not satisfactory when employed to precipitate gold from liquors running lower than 0.04 per cent. in cyanide. The importance of this fact will be better appreciated when it is remembered that, in plants for the treatment of slimes, solutions much weaker than 0.04 per cent. are in use, and therefore, if the zinc method is employed at an ordinary tailings treatment works, and a plant be subsequently erected to work the slimes, a Siemens-Halske precipitation plant must be put up side by side with the existing zinc boxes, and two distinct systems must be run simultaneously, thereby involving much useless labour, as the two sets of storage vats must be kept entirely separate. A further point in favor of the Siemens-Halske system is the low consumption of cyanide, which is rendered possible only by the very weak solutions which can be used without interfering with satisfactory precipitation. The cost of actual precipitation is about the same by either method.

In giving the foregoing outline of the ordinary *régime* of Rand cyanide treatment the writer has assumed the plant to be fitted with Siemens-Halske boxes, and has given the strength of the solutions employed accordingly. A plant operating with zinc precipitation



CYANIDE VATS; AN OLD STYLE INSTALLATION.
The concrete vats have generally been superseded by wooden ones.

would, of course, use solutions of considerably greater strength. On the Rand the ores are simple, and contain, as a rule, no base constituents other than iron pyrites; yet, even under such conditions, the electrolytic method is slowly ousting zinc as a precipitant. If the ores were complex and contained base metals readily soluble in cyanide, the relative merits of the two processes would be much more strikingly illustrated, as the use of very weak solutions would, in many instances, be absolutely essential to satisfactory treatment. Many other methods of precipitation have been tried, but none have come into common use. The Bettel process, in which zinc is employed as a cathode, is now being tried, with promising results, at the New Comet mine, and the Zerener and Sulman processes will in all probability make their appearance on the Rand shortly. In the former sodium amalgam (electrolytically formed) is used; in the latter, zinc fume in a special patented apparatus.

The question of first cost is a serious one in so isolated a centre as Johannesburg. Roughly speaking, a well equipped modern cyanide plant costs not less than £300 per stamp. This figure includes tailings wheels, mechanical haulage, rails, trucks, power installment, collecting vats, leaching vats, spitzlüten, spitzkasten, solution storage vats, precipitation house and plant, foundations and excavations, pumps, pipes, launders, etc.

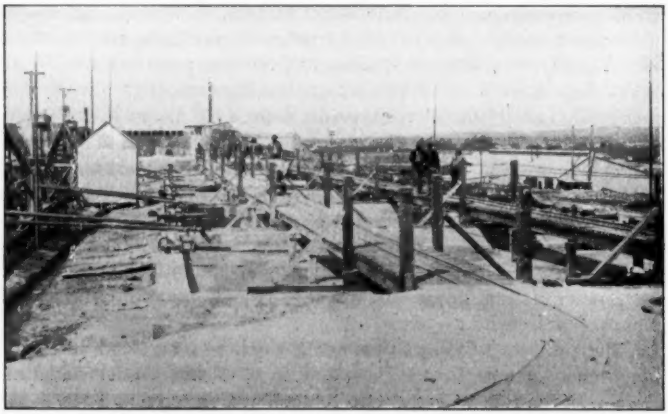
The problem of slimes treatment, which so long stood unsolved, has been overcome by the perseverance of Messrs. Butters and Von Gernet, of the Rand Central Ore Reduction Company, and Mr. J. R. Williams, consulting metallurgist to the Crown Reef Mine. The

former agitate the slimes with about twice their weight of weak cyanide solution in vats fitted with mechanical stirrers. When the gold has gone into solution (after about four hours' agitation), the slimes pulp is settled by means of lime, and the clear liquor decanted off and precipitated in Siemens-Halske boxes. A fresh lot of still weaker solution is then run into the vat, and the stirrer (which is set just above the level of the settled pulp) re-started. When the whole of the pulp is again in suspension, the stirrer is stopped, the slimes are settled, and the liquor is decanted off as before. Finally, the slimes are stirred up with water and discharged.

The precipitation plant has to be very large, as four to five tons of liquor have to be precipitated for every ton of dry slime treated.

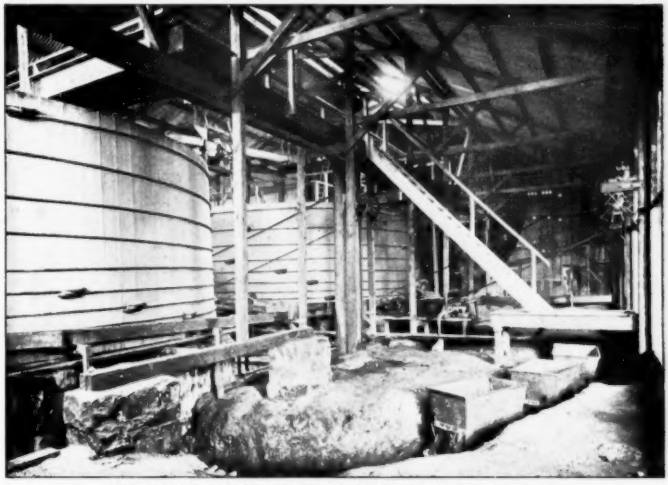
Mr. Williams's method differs somewhat from the other in mechanical details, but otherwise the two processes are identical. In both cases all solutions are precipitated electrolytically, the boxes being made twice the size of those used in the ordinary sands treatment.

In order to reduce the volume of the slime water (as it comes from the small sands spitzkasten at the cyanide works), it is passed through very large settling spitzkasten before being admitted to the slimes works proper. Five or six pounds of lime are added to every ton of slime contained in the slime water, before the spitzkasten is reached, and, if the settling area of the latter be sufficient, nothing but clear water overflows from it, the slimes being completely deposited in transit. Before entering the spitzkasten the proportion of water to solid slime is about 30 to 1, but the slime product discharged from the spitzkasten delivery-pipes is concentrated down to a ratio of 3 to 1. This



CYANIDE VATS; THE TOP OF AN OLD STYLE INSTALLATION.

thick pulp is again settled in a vat, and the clear water decanted off, leaving a slime product consisting of water and slimes in the ratio of 3 to 2 and ready for treatment as already described. To settle the slimes from a 100-stamp mill it is necessary to have a spitzkasten 35 feet by 25 feet, divided into thirty-five compartments, each 5 inches square by 5 inches deep. As the water flowing off from the spitzkasten is immediately pumped back to the battery reservoir, there is a comparatively small quantity in circulation altogether, and this becomes so thoroughly impregnated with lime that it is not necessary to continue adding the five or six pounds above mentioned. This prac-

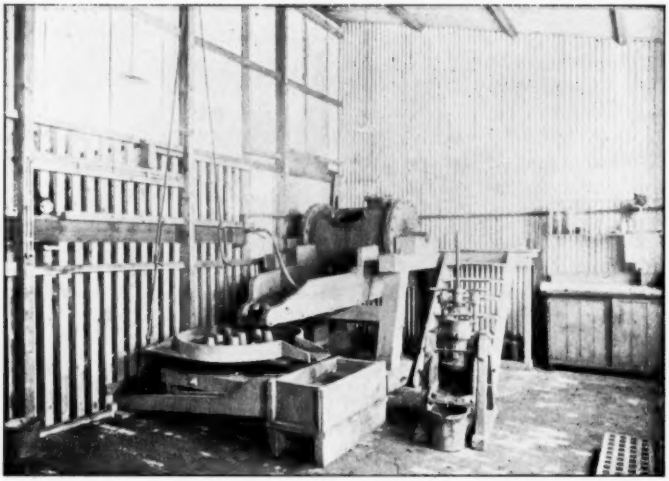


BOTTOM OF CYANIDE VATS, SHOWING CARS FOR EMPTYING.

tice of circulating a limited amount of water for battery purposes may lead to novel developments in metallurgical practice on the Rand. As pointed out by a recent writer, it is conceivable that, through this innovation, a radical change may be effected in ordinary milling practice by the substitution of a weak solution of cyanide for water in the mortar boxes. There is apparently no reason why this should not be done advantageously. The quantity of solution in circulation would not amount to more than five or six tons per stamp; there would be no chance of loss of liquor beyond that entailed by causes at present in operation; a considerable proportion of the fine gold of the slimes would be dissolved with great rapidity in the mortar boxes, owing to the free access of air to the latter and the intimate contact of each particle with the solution; and, lastly, the solutions in use at the Sands

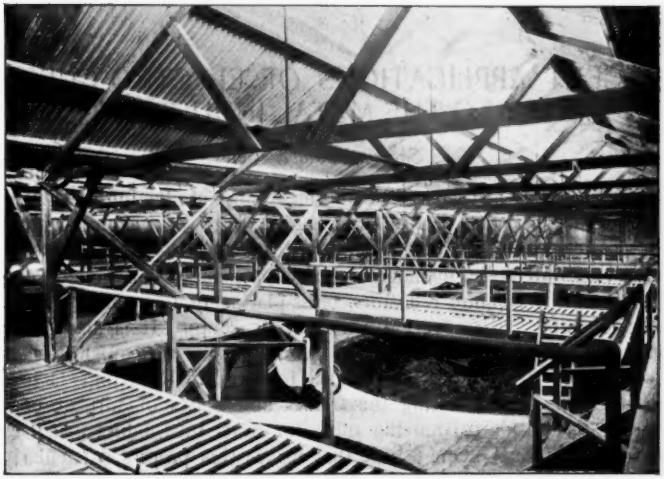
Cyanide Works would not be diluted, as at present, by the water delivered with the tailings. If it was found that the gold was effectively dissolved before the slimes reached the slimes works, the latter could be curtailed in size, as only settling and washing would be necessary in the way of treatment prior to precipitation of the liquor.

Another disputed question on the Rand is that of dry crushing and direct cyaniding. It has frequently been urged that the present method of treating the Rand ores could be improved upon by abandoning amalgamation altogether, crushing dry, and extracting the gold by means of cyanide only; but, though several attempts have



A CLEAN-UP ROOM.

been made to verify this theory, the results of such departures have been disappointing. Where oxidised surface ores have to be dealt with, no doubt dry crushing followed by cyaniding may be made to work satisfactorily. This is due, first, to the fact that such ores are in a more or less porous state, and may therefore be crushed very coarsely, as the cyanide solution can thoroughly permeate each particle, and, secondly, to the fact that the original auriferous pyrites has been completely oxidised, and therefore gives a higher and quicker extraction when subjected to cyanide. The percentage of such ore, however, is very small, and the material which really has to be considered is the pyritic, or "blue," rock of which the vast bulk of the Rand ores now being worked consists. A totally different problem is presented here. The rock contains a large amount of



TOP OF TAILING VATS, CYANIDE WORKS, SHOWING TRACKS AND SCREENS FOR FILLING.

pyrites, much of which is comparatively coarse. If dry crushing and direct cyaniding are to be employed, it will be necessary to crush very fine, in order to expose as many surfaces as possible to the solvent. If, however, the crushing be carried beyond a certain limit, a large proportion of fines will be formed, and these again will prevent, or greatly impede, subsequent leaching. As this would be inadmissible, the crushing can be conducted only within such limits that in the final product there will be a very appreciable amount of coarse pyrites. To extract the gold from the latter a prolonged cyanide treatment is necessary, but, as it is impossible to concentrate dry economically, the same length of treatment must be given to the whole ore crushed, thus involving a plant of enormous dimensions. As it does not seem probable that the costs of actual crushing could be lessened by substituting dry for wet milling, the only apparent advantage that can be claimed for the former is the comparatively low cost of installation, against which, however, must be set the increased expenditure on cyanide plant necessitated by its adoption.

In conclusion, it may be remarked that, although it has often been said that "the cyanide process made the Rand," yet, if we remember that the process had been worked with indifferent success previous to its introduction to South Africa, we may with equal justice say that "the Rand made the cyanide process."

RECENT APPLICATIONS OF ELECTRO-CHEMISTRY TO THE METAL INDUSTRIES.

By Sherard Cowper-Coles.

ELECTRO CHEMISTRY and metallurgy are beginning to play an important part in large engineering works; for instance, electricity is being employed for electro-galvanizing, removal of mill scale, manufacture of copper tubes and condensers, production of metallic reflectors, brass-plating of iron and steel fittings of ships, and recovery of tin from tin scrap. It is also being introduced in allied industries, such as the manufacture of white lead. The first of these processes referred to—*viz.*, galvanizing—is extensively used for coating the frames and plates of torpedo-boat destroyers and for galvanizing tubes for water-tube boilers, such as the "Belleville." One feature that makes this process particularly suitable for this class of work is that it does not hide defects or cover them up. Nor does it reduce the tensile strength of iron and steel of small section, or distort it, as in the case of hot galvanizing. But it shews up any defect or flaw in the steel, saving a considerable amount of time and money, as any weakness in the tube or plate is found out at an early stage instead of at the final stage. Other advantages of electro-galvanizing are that the plant can be worked intermittently without loss, and varying thicknesses of zinc can be employed at the will of the operator. The zinc usually applied to such work as boiler tubes weighs ¾ ounce to 1¼ ounces per square foot. The process of electro-galvanizing consists, first, in removing the mill scale and rust from the work to be galvanized, either by immersing in an acid solution or by sand blasting. It is then placed direct in the galvanizing bath,—a solution of zinc sulphate, about 30 ounces to the gallon of water. The work to be galvanized is suspended to a bar or girder running across the bath, by means of gun metal dogs; the electric current is conveyed into the solution by means of lead plates, the voltage at the terminals of the dynamo being about 6, and the number of amperes per square foot of cathode surface 15 to 20. The solution is rapidly circulated through the bath by means of a small centrifugal pump, and is regenerated, as the zinc is removed from it, by passing it over a filter-bed composed of carbon, coke, or sand mixed with zinc dust, which is obtained as a by-product during the distillation of zinc from its ore.

Fig. 1 shews a plant suitable for coating plates and angle irons up

to 25 feet in length, and Fig. 2 a plant specially designed for coating the tubes of Belleville boilers. Fig. 3 gives plan and elevation of a plant, shewing the regenerating tanks and circulating arrangements.

The removal of mill scale is a matter of considerable moment with many large engineering firms. The ordinary pickling process is tedious and costly, and electricity is now being used to hasten the process.

The removal of mill scale from forgings and plates has always been a matter of difficulty, the scale in many cases being $\frac{1}{32}$ of an inch in thickness, and very adherent. The usual practice is to place

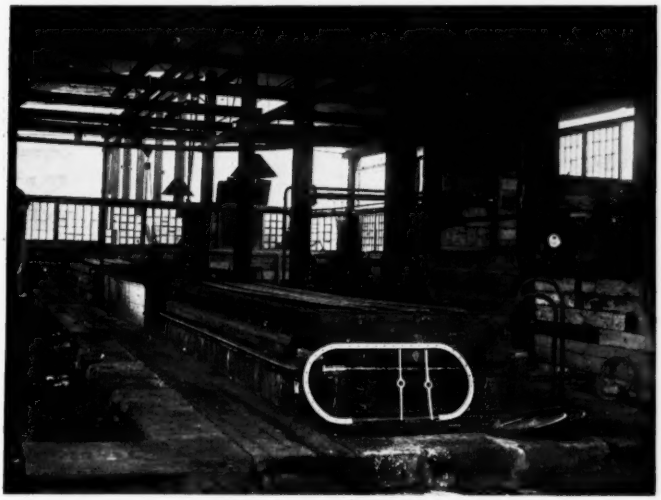


FIG. 1. ELECTRO-GALVANIZING PLANT FOR PLATES AND ANGLE-IRONS.

the iron in a solution, containing 1 part of hydrochloric or sulphuric acid to 10 parts of water, for a period varying from ½ to 24 hours,—½ an hour for close annealed sheets, such as are used for roofing sheets, 24 hours for plates and forgings, such as are used for ship and bridge building. Many attempts have been made to quicken the process and to reduce the cost. One of the first experiments was to make the iron to be pickled the anode in an acid bath; this was found to pit the plates, as the iron which was not protected by the mill scale was more readily dissolved than that covered by the magnetic oxide. To overcome this difficulty, the current is reversed every few minutes, the iron being alternately made anode and cathode. Fig. 4 shews a transverse section of a pickling vat con-

FIG. 2. PLANT FOR COATING BELLEVILLE BOILER TUBES.

structed for such a process, the work being suspended on the bars placed across the vat. To quicken the process and reduce the electrical resistance of the solution, it is found advantageous to heat the pickling solution or electrolyte, which is done by means of a lead pipe, G, through which exhaust steam is passed. In the illustration, a tray or false bottom, B^3, is shewn, capable of a vertical movement between guides provided on the inside of the vat, the object of the tray being to catch the heavy mill scale as it falls from the plates. The tray, at the end of the day's work, is allowed to float to the top of the solution, so that the mill scale collected can be removed. To sink the tray when necessary, extensions, B^2, are provided, at each corner, and these are connected to flexible connections which pass round guide sheaves and are attached to a drum or winch which is rotated when it is desired to sink the tray. To float the tray the pawls are released from the winch.

Another device for catching the scale soon after it is removed from the plates, so as to prevent the further unnecessary consumption of acid by disolving the mill scale and oxide after removal, has been tried with most satisfactory results. The solution is circulated by means of a small pump through a lead-lined box or chamber, behind which are placed electro-magnets, the result being that, as the solution flows past the poles of the magnets, the magnetic iron and oxide

in suspension are retained, and can be removed from time to time, thus effecting a considerable saving of acid.

In America an electrical pickling process has been tried, the solution used being sulphate of soda or sulphuric acid. The plates to be cleansed form the negative electrode, and an iron plate the positive electrode. The hydrogen set free from the surface of the plate reduces the oxides on the surface, and decomposes any grease that may be present.

A voltaic method is said to do the work with more certainty and with less danger to the surface of the metal in the way of pitting.

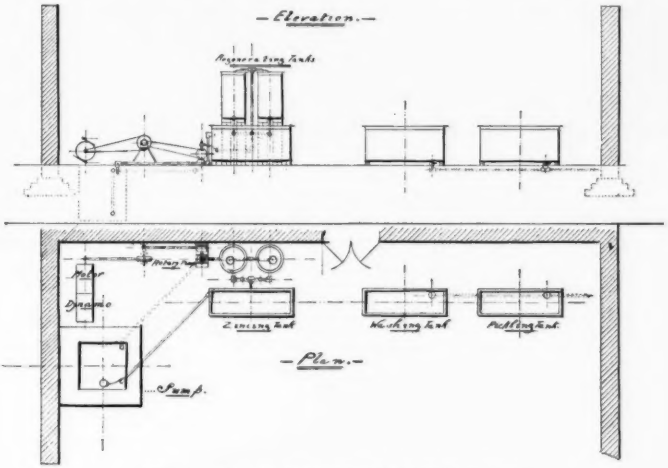


FIG. 3. PLAN OF ELECTRO-GALVANISING PLANT.
Showing Regenerating Tanks and Circulating Arrangements.

The articles to be cleaned are used as the positive pole of the battery, the negative pole being either carbon or wire gauze electro-plated with silver and covered with amorphous platinum black. The bath consists of dilute sulphuric acid, containing a depolariser, such as nitric or chromic acid. The use of the latter agent, it is claimed, completely prevents the evolution of offensive gases. The storage of the electric current produced during the pickling process has been suggested.

Attempts have been made to remove the mill scale by drawing it away from the plates with powerful electro magnets, the scale having been previously loosened from the metal by a short immersion in an acid bath or by heating.

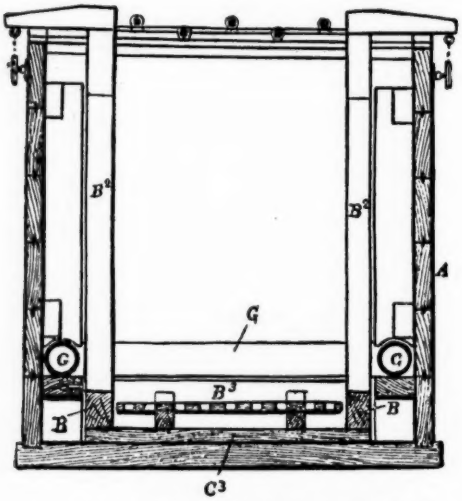


FIG. 4. PICKLING VAT FOR REMOVAL OF MILL SCALE.

Parabolic reflectors, which have hitherto been made exclusively of glass both for lighthouses and search-light purposes, are now being made by electro-metallurgical means. On a highly-polished surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished so as to make adherent the copper backing subsequently electro-deposited upon the silver. The glass mould, after silvering, is placed in a suitable ring and frame, as shewn in Fig. 5, and then immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position at a rate of fourteen revolutions per minute. The copper adheres firmly to the silver, and together they form the reflector, which is finally separated from the glass mould by placing the whole in cold or lukewarm water and gradually raising the temperature of the water to 120° F., when the metal reflector will leave the glass mould because of the unequal expansion of the two. The surface obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish. It requires no further treatment to answer all the purposes of a reflector, except that it must be coated with a film of some suitable metal, such as palladium or platinum, which is found to resist tarnishing to a wonderful degree.

The glass bells of electric incandescent lamps are now fitted with reflectors, the silver being thrown down chemically on the upper

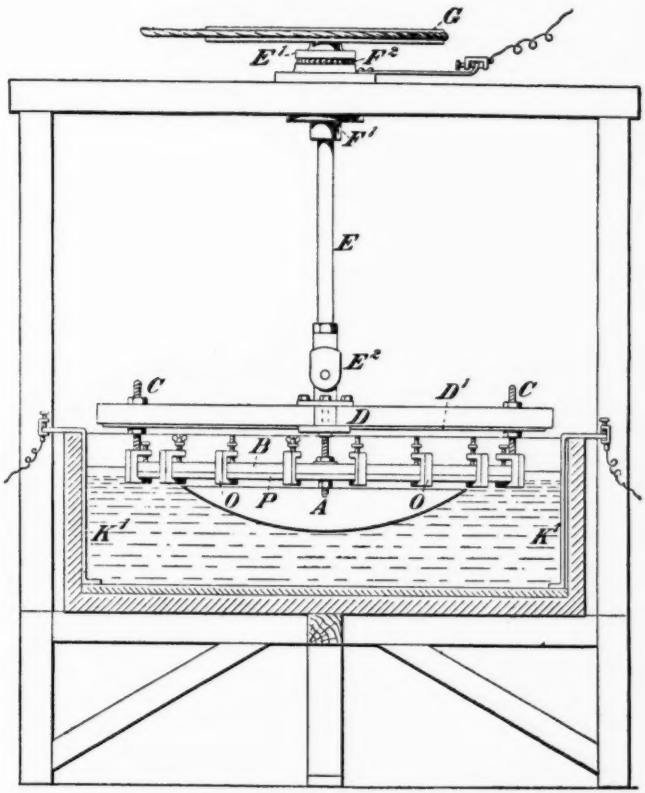


FIG. 5. APPARATUS FOR MAKING PARABOLIC REFLECTORS.

part of the glass bulb, and protected with a film of electro-deposited copper.

The deposition of copper is carried out in many large engineering works, for the coating of hydraulic rams, barrels of guns, and shot, and, as is well known, is now extensively employed in the manufacture of copper tubes for condensers and large evaporating pans.

Copper is being largely used for the coating of constructive iron work for protective and ornamental purposes. A large piece of work has recently been executed for the dome of the Philadelphia city hall tower. In this case 20,000 square feet of surface were coated with copper, the weight of copper deposited per square foot being 11

ounces. The iron work was boiled in a solution of caustic soda for the purpose of removing all grease or fatty substances. From this tank the iron castings were placed in a pickling tank made of wood, lead-lined, and containing a 10 per-cent. solution of sulphuric acid kept at a temperature of about 150° F., the iron work being immersed in this solution from two to six hours to loosen or remove all rust, silica, or other matter, and finally brushed with wire brushes. After this treatment the iron work was placed in an alkaline copper tank to receive the first coating of copper. From this tank, after a short immersion, the work was transferred to a copper sulphate solution, where it was kept until it had received the desired thickness of copper. As a final operation, the coppered iron was placed in a tank fitted with aluminium and tin anodes, where it received a further coating corresponding to 2½ ounces per square foot. It is claimed that this coating consisted largely of aluminium.

In many engineering shops, in the case of work in which strength combined with handsome appearance is required as well as protection from corrosion, iron and steel fittings are used with an electrically-deposited coating of brass.

The cells for depositing brass are similar in construction to those used for nickel plating, the anodes being of rolled sheet brass. The double salts of cyanide of potassium and copper give good deposits, when worked hot. The colour of the deposit can be altered from a bronze to a bright yellow either by rocking the work in the bath or by using different current densities. In many cases the bath is made up by first electrolytically dissolving sheet-brass anodes in a solution of cyanide of potassium, or by first dissolving the desired quantity of copper from a copper anode, and then dissolving the desired quantity of zinc from a zinc anode. A strong current density has a tendency to deposit a larger percentage of zinc, a weak current to deposit a greater portion of the more electro-negative element, copper.

The recovery of tin from tin scrap by electricity is carried out in nearly all districts where much tin scrap is produced. In Russia Nikolojev has established works at Nishni Novgorod producing 1,500 poods of tin (recovered from tin scrap).

A great number of processes have been patented, and satisfactory results have been obtained with solutions of sodium stannate. Alkaline hydroxide, especially caustic soda, has been also extensively employed, as the tin dissolves readily, and without the aid of electricity, in a warm solution of caustic alkalies, hydrogen being evolved. Iron, however, is almost entirely insoluble in such solutions, the electric current being used merely for precipitating the tin. A process has lately been brought out in America for extracting tin from tin-plate

waste. The waste tin plate is submitted to the joint action of a current of electricity and a bath consisting of a solution of caustic alkali, until the recovery of the tin is retarded or ceases and the bath becomes charged with tin salts. Phosphoric acid is then added, causing a precipitation of tin oxide. Calcium oxide is finally added to the bath, causing a precipitate of calcium phosphate. Acid solutions, such as sulphuric acid, have also been employed for the recovery of tin, but the process is found to be costly, as the amount of ferrous sulphate produced is very considerable,—for instance, 6 tons of tin scrap producing about 28 tons of ferrous sulphate, at present of little value.

Electrolytic methods are now being substituted for the slow and tedious Dutch method of manufacturing white lead. To hasten the process the following system has been devised by Prof. C. V. Gardner, and is being worked on a commercial scale by the Universal White Lead Co., at Millwall. The lead is cast into thin sheets about 20 inches by 15 inches, weighing between two and three pounds each. These sheets are corrugated and packed between sheets of coke or carbon, which form the negative electrodes; strips of tin make the connection between the lead or electro-positive plate and the carbon electrode, so that, when subjected to warm vapours of acetic acid, carbonic acid, and atmospheric air, electrical action is set up between the two, hastening the corrosion and lessening the time required to reduce the plates into hydrated carbonate of lead from ten or fifteen weeks (the time required by the old Dutch process) to five weeks.

Another electrolytic process consists in electrolysing a 10-per-cent. solution of sodium nitrate in a wooden cell provided with a porous diaphragm, the anode being made of pig lead and the cathode of copper. In the former compartments the lead dissolves as nitrate, while round the cathode caustic soda is produced. The two solutions are then drawn off and mixed, the alkaline nitrate being thus regenerated and the lead precipitated as hydrate. The hydrate is finally treated with sodium carbonate to convert it into white lead. The caustic soda formed as a by-product in the latter operation has only to be re carbonated to be available again.

A somewhat similar process, patented by Mr. Brown, is carried out by electrolysing sodium or potassium nitrate solution in a wooden vessel divided by a porous partition into two cells, one of which contains pig lead and the other a copper cathode. A double salt of lead is formed at the anode, and alkaline hydroxide and free hydrogen at the cathode. The two solutions are mixed, lead hydroxide comes down, and alkaline nitrate solution is left, the original alkaline salt

being regenerated. The solution containing lead hydroxide in suspension is then run into a settling-tank, from which the clear solution is subsequently run off, when it is used again as the electrolyte, the lead hydrate being finally exposed to the air, or to an atmosphere of carbonic acid, to convert it into hydrated carbonate of lead.

Another process patented in America consists in passing an electric current from an anode of metallic lead, through an alkaline electrolyte consisting of a solution of salt of ammonia in combination with any acid which will produce a soluble lead salt (including sulphuric acid) and of a bi-carbonate of an alkali, to a cathode of lead, carbon, or other suitable material. This causes a decomposition of the salts in the electrolyte, and a formation of a soluble compound of lead, which is transformed into hydrated carbonate of lead; while the simultaneous generation of free carbonic acid at the anode in the presence of caustic alkali (ammonia) generated at the cathode, passing a current of carbonic acid gas through the electrolyte, regenerates the spent alkaline carbonate until the anode is completely dissolved. Both acetate and bi-carbonate of soda are constantly regenerated, the process consuming only lead, carbonic acid, and water.

An English process, which has lately been protected, consists in decomposing acetate of ammonia by electrolysis, lead anodes being used, which are separated by porous diaphragms made out of stout Willesden paper insulated from the bottom to prevent irregular electrolytic action in the electrolyser. A lead solution is produced; also caustic alkali; and on mixing the two solutions, white lead is precipitated.

In another process, patented in Germany, lead anodes three mm. in thickness are employed for the electrolysis of a solution containing 300 cc. nitric acid and 2,000 cc. of water. The lead salt formed is precipitated as white lead by means of a stream of carbonic acid gas. Any silver contained in the lead is deposited on the cathode, and can be recovered.

At a future date I hope to give particulars of various other electro-metallurgical and chemical operations in engineering shops.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

By James B. Stanwood.

THE inadequacy of automatic variable cut-off devices for controlling the distribution of steam in non-condensing engines under great variation of load was discussed in an article in the May number of THE ENGINEERING MAGAZINE. The belief was expressed that control by means of a throttling governor would be more satisfactory, and this belief was endorsed by the opinion of an eminent American engineer and the practice of a celebrated English designer.

In this paper it is proposed to consider the advantages and disadvantages of throttling governors as applied to non-condensing compound engines.

The fundamental difference between the two systems is this: For variations in load, the expansion governor adjusts the mean effective pressure (m. e. p.) by varying the volume of steam admitted to the engine, the pressure being always constant; the throttle adjusts the m. e. p. by varying the pressure of steam admitted to the engine, the volume being always constant.

It was shown in the other paper that the small m. e. p's necessary for light loads can be produced only by automatic expansion gears in connection with three induced losses,—to wit, first, expansion below the atmosphere, called the "drag" loss; second, a clearance loss; third, a cylinder condensation loss,—each of which becomes greater, the smaller the m. e. p. and the lighter the load.

The distinguishing features of throttling governing are, first, that the "drag" does not appear until the m. e. p. is very small (with high steam pressure the "drag" can be prevented, except when the load on the engine is so small as to be but slightly greater than the friction of the engine itself); second, the clearance loss decreases as the m. e. p. and load decrease; third, the cylinder condensation loss decreases as the m. e. p. and load decrease.

Diagram 1 indicates how, by throttle control, without expansion below the atmosphere, a smaller m. e. p. can be obtained than by expansion governing. A B C D E represents the maximum diagram that can be obtained theoretically with 200 pounds' steam pressure (an extreme case) and four expansions; back pressure being 15 pounds absolute, the m. e. p. obtained is 110 pounds. Diagram F G D E represents the smallest m. e. p. that can be obtained with a terminal pressure of 16 pounds with four expansions, the initial press-

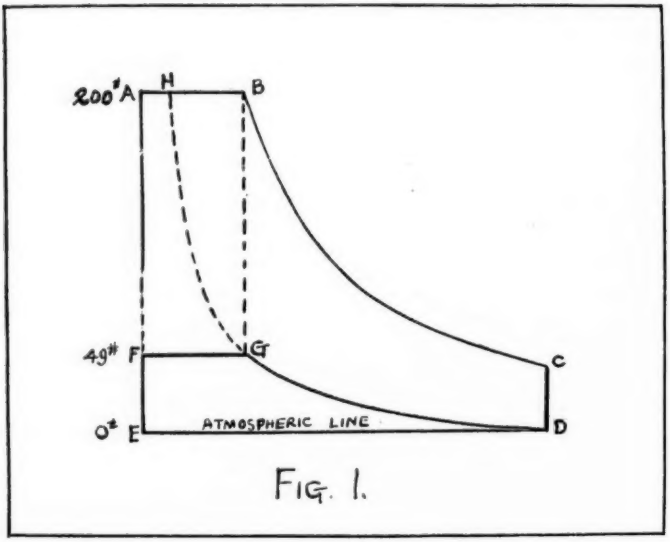


FIG. 1.

ure being 49 pounds, reduced to that pressure by a throttling governor; this m. e. p. is about 21 pounds. The diagram A H D E is the smallest that can be produced with a terminal pressure of 16 pounds under expansion governing which maintains a constant initial pressure; the m. e. p. of this diagram is 38 pounds—nearly twice that obtained by means of a throttle. In practice these m. e. p's cannot be secured, the actual being about two-thirds to three-fourths as great; but the diagram shows the relation existing between maximum and minimum loads under both systems of control.

The reason that there is a reduction of the clearance loss under throttling governing is due to the fact that the clearance spaces are filled with steam at low pressure when the load is light, because the initial pressure is reduced by the throttling effect of the governor; the steam, for instance, at 49 pounds' pressure weighs less than one-third of the weight of an equal volume at 200 pounds' pressure, reducing the loss accordingly.

It follows that, with a reduction of the initial pressure by means of the throttle, the initial temperature of saturated steam is reduced; therefore the fluctuation of temperature in the cylinder is less, thereby checking cylinder condensation. This shows that the cylinder condensation loss becomes less as the m. e. p's become small. Another

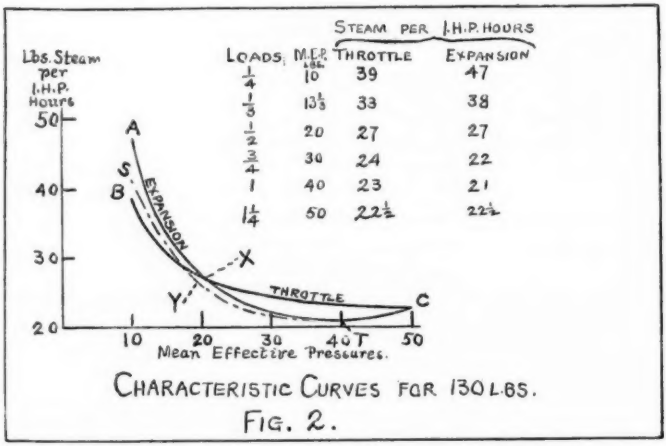
important consideration to be noticed is the fact that the steam is super-heated by the wire-drawing effect of the throttle, converting the saturated steam into super-heated steam. This super-heat in the steam becomes a source from which heat is drawn to reheat the cylinder (previously cooled by expansion and exposure to the exhaust) without unnecessary condensation of fresh steam from the boiler for that purpose. It will also be noticed that, as late fixed cut-offs can be used with a throttling governor, there is no tendency to excessive cooling of the cylinder on account of excessive expansion at early cut-off, as is the case with engines with automatic cut-offs under light load.

This shows that where expansion governing fails throttling governing has no disadvantages. The chief criticism on the score of economy that can be raised against the throttle is that, in the range between light load and over load, there is a point or range of load at which expansion governing is more economical, on account of the advantage it has in securing a rate of expansion greater than that which must be selected for throttle control, if the same maximum power is to obtain in each case.

This loss of economy by throttling governing (at about three-fourths load) can be almost entirely prevented, if a larger ratio of expansion be employed, equivalent to that which develops by expansion governing at its most economical point. This advantage, however, is obtained by a limitation of the engine's power, so that over-loads cannot be carried without an increase of steam pressure. It is also probable that the very light loads would be carried with less economy, on account of an earlier appearance of the "drag" and a slight increase of clearance and cylinder condensation loss, due to greater expansion.

A study of the "characteristic curves" of both types of engines will make these points clearer. The experiments of Mr. Willans form the principal basis for the determination of characteristic curves of throttling engines under variable loads, and the results have been partially confirmed by the writer's experience with this type of engine; they are also indicated by theoretical considerations. The most important fact to be noticed in connection with these curves, as is shown by Fig. 2, is that with throttling governing the water per i.h.p. decreases continually as the load increases, but with expansion governing the water per i. h. p. decreases at first with increase of load, until the best economy per i. h. p. is reached, after which it increases. A careful experimental investigation into characteristic curves of properly-designed engines of both types is most desirable.

In Fig. 2 the curve A X C represents the pounds of steam used



CHARACTERISTIC CURVES FOR 130 LBS.

FIG. 2.

per i. h. p. per hour by an automatic cut-off non-condensing compound engine, steam pressure 130 pounds, maximum m. e. p., 50 pounds. Curve B X C represents the pounds of steam used per i.h.p. of a throttling non-condensing compound engine with the same steam pressure and maximum m. e. p. Thus the best economy is secured by the automatic engine at about 40 m. e. p., when the water rate is about 21 pounds; the water rates of both engines are identical at 50 pounds m. e. p, when it is about 22½ pounds per i. h. p. On light loads, however, the water rate on the throttling engine is much less than with the automatics, on account of the flatter character of the throttling curve from X to B. The point X, where the two curves cross, is the point at which the gain by expansion in automatic engines is neutralized by induced losses. The dotted line S Y T shows throttle characteristic for maximum economy—no over-load.

Fig. 3, although out of the range of experience, shows the characteristic curves which the writer expects, with 200 pounds' steam pressure, for both throttling and automatic engines. The throttle has the longer period of nearly constant economy,—from 15 pounds, m. e. p. with a water rate of 31 pounds to 75 pounds m. e. p. with a water rate of 21 pounds.

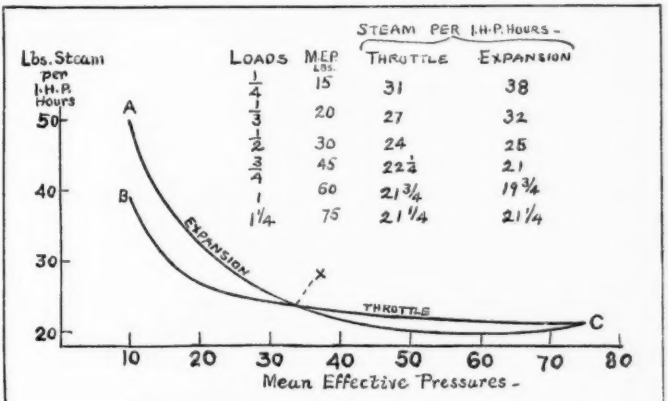
In addition to marked economic advantages at light loads, a number of mechanical advantages are offered by throttling governing.

As was pointed out in the May number, the low-pressure cylinder of a non-condensing automatic compound engine is frequently converted, under light loads, into a pump which has to be dragged along

by the high-pressure cylinder; this condition, in connection with the development of a loop in diagrams taken from the high-pressure cylinder, makes it impossible, with certain classes of valve gear, to operate these engines quietly at light loads. Indeed, it is only with piston valves, or the best forms of balanced valves, that compound non-condensing automatic engines can be made to run at all smoothly under light load. Even then the engine must be of the tandem type, in order to secure by the net action of both pistons a positive pressure upon the crank pin. This unmechanical arrangement is also necessary whenever the main shaft governor is employed, and the adjustment of the cut-off of both cylinders has to be brought under the control of the governor, because the complication and expense of the valve gear are greatly increased in engines of the cross compound type, especially with cranks at right angles.

On the other hand, these difficulties can be avoided, if a throttling governor is used; its employment makes the non-condensing cross-compound engine practicable. The principal reason is that the low-pressure cylinder continues to perform work with the very small m. e. p's which accompany light loads, without the development of any very serious "drag," and that no loop appears in the high-pressure diagram.

The superiority of cross compound engines with cranks arranged at right angles are numerous. First the fluctuations of impulses which



Loads	M.E.P. Lbs.	Steam per I.H.P. Hours — Throttle	Expansion
1/4	15	31	38
1/3	20	27	32
1/2	30	24	25
3/4	45	22½	21
1	60	21¾	19¾
1¼	75	21¼	21¼

CHARACTERISTIC CURVES FOR 200 LBS.

FIG. 3.

the fly-wheel receives from the engine are small, so that a very light fly-wheel may be employed; or, if the variations of load are very severe, nearly all the momentum of the wheel is available for steadying the action of the engine. On this account very sensitive governors can be used. Second, the pistons of both cylinders are very accessible. And, third, the magnitude of the strains in the engine are only one-half of those developed in a tandem engine of a similar power.

All these and other advantages are secured by using the throttle.

Engines of the throttling type can be operated successfully at almost any speed, especially at low speed, as the fly-wheel is not called upon to carry the entire load of the engine every time a crank passes a center, and the valve gear places no limitations upon the number of revolutions. Again, in case of repairs for either high- or low-pressure engines, one or the other may be operated singly under control of the governor at half-load. In this connection the engines can be converted into a pair of simple engines, still under control of the governor, by a simple application of a three-way valve with proper pipe connections placed between high- and low-pressure cylinders. The value of such an arrangement appears when the steam pressure is unavoidably low and the loads are exceptionally great.

There are two serious objections to throttling governors. One, already mentioned, is that, in order to secure the most economical results for light and over-loads, the best possible rate of expansion (which corresponds with a range of load from one-half to full load) cannot be obtained. It is obvious that, if a small ratio of expansion is required for a light load and also for an over-load, and if that ratio of expansion must necessarily be fixed, a greater ratio of expansion, which may be more economical, has to be abandoned. On the other hand, the gain in economy in non-condensing compound engines from increasing the ratio of expansion is very slight, as is shown by the characteristic curves.

The second objection relates to close regulation. As a rule, compound engines of any type do not govern as closely as single-cylinder engines. A great amount of time and attention has been bestowed upon the main shaft governor in connection with single cylinder high-speed engines, producing an instrument of marvelous simplicity and a high degree of refinement; but throttling governors have never received the same amount of study and care. In England the throttling governor, in the hands of Mr. Willans and others, has been developed to some degree, and the status to-day is this: the throttling governors control as closely as the best main shaft governors of three or four years ago.

It has always been a serious problem in the growth of industrial

plants to prepare for the proper increase of power. The range of speed for most types of engines is limited by the form of valve gear or governor. Now, the power of the engine (provided it is sufficiently strong and suitably designed) can be increased by increasing its speed and its boiler pressure. The cross compound throttling engine possesses superior advantages in this respect; it can be operated at almost any speed and at any boiler pressure. On this account an engine can be installed at a low number of revolutions, corresponding, say, to 400 feet piston speed and 100 pounds' boiler pressure, and can be operated with economy equivalent to that of a good Corliss engine similarly loaded. Later the piston speed can be increased gradually to 600 feet, if necessary, and the boiler pressure to 150 pounds, thereby increasing the maximum power of the engine 125 per cent., and securing also a gradual improvement of economy. The increase of engine speed can be obtained by enlarging the receiving pulley on line shaft or generator, as loads may determine. There is no difficulty to-day in providing for 150 pounds' working pressure in the boiler. To the writer's knowledge there is no other way by which so great a range of power can be obtained with non-condensing engines, at the same time maintaining so uniform a degree of good economy.

To sum up, we find that throttling governing, with non-condensing stationary engines, is especially adapted for high steam pressure; it improves an engine's economy at light loads; it makes the cross compound engine practicable, and thereby produces a type of engine which may be operated at any speed. It is believed that, when these advantages are more thoroughly understood, the throttle will receive more attention from designers, and that improved constructions and methods of application will be evolved.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

THE Newton Machine-Tool Works, located at the corner of Twenty-fourth and Wood streets, Philadelphia, puts out a line of cold-metal sawing machines, milling machines, and traversing, spindle, boring, milling, and drilling machines of new and most convenient designs, now rapidly winning their way to established reputation.

The theory of expense-division underlying the cost-keeping system in use at the Newton shops is the same as that at Strieby & Foote's, in that the total expense account is apportioned among the machine tools, so that each shall bear its proper hour-rate, making the materials and time charged against any piece of work represent the total cost of the product to the shop. The Newton shops are a machine shop exclusively, having neither foundry or smithy. As their machine-tools are comparatively numerous, and their floor-hands few, the machine tool rates fix the principal part of the costs. It is quite within the capacities of the individual tool hour-rate system, however, to deal with any ratio of floor-hands to machine-hands, as the floor itself can be assumed to bear any suitable share of the expense account, a division of which share by the average number of floor-hands gives the total cost of the floor man's work-hour, precisely as the machine hand's total hour-cost is obtained.

There seems to be really no essential difference in the practical workings of cost systems, let the expense account divisor be what it may. If the total expense of the preceding year is divided by the total actual labor cost of that year, as in the Bement and Miles method, then with less men at work the expense percentage to be added to the labor account and materials totals to obtain total-cost is too small. So, if a tool or several tools stand idle, their proportion of the expense account remains unchanged by the Strieby & Foote and Newton method. Evidently the only, or rather the most obvious, correction of this deficiency is to be found in a sliding scale of percentage per man at work. As has been before mentioned, a reduced force of workmen does not mean a corresponding expense reduction; these two cost factors are wholly independent of each other, so that it is possible that the larger total expense account will be made with the smaller number of hands at work. In the fluctuations of trade there might be a reduction of 50 per cent. in the number of hands at work, without any decrease in the expense account total; in fact, the

latter might even be augmented through extraordinary efforts to obtain business. With a constant or nearly constant number of hands at work, no serious error could arise from the use of an expense percentage fixed on the preceding year's totals. With a notable fall or rise in the number of hands at work. however, such a percentage might give largely misleading results. But, having the last year's expense total in hand, it is always a simple matter to find an approximation to correct present expense percentage based on the number of hands now at work.

An order received in the office at Newton's is transmitted to the drawing room in regular course, where it receives an order card as given below—size 2¾ inches × 4⅝ inches.

ORDER CARD.

Date.....189 Sets.....Symbol.... .....
For.....
To be Shipped.....
Drawings.....
Notes.....

(ORDER SENT OUT.)

Deliver no goods Without Bill (numbered as ordered).
Send statement of account first of each month.
Foundry Order No..... Philadelphia,..... 18.....

FROM NEWTON MACHINE TOOL WORKS,
Twenty-fourth and Wood Streets.

To.....

Please make Castings from patterns below mentioned. Castings to be sound and free from blow-holes, cold shots, and all imperfections. Iron to be of good quality, and soft enough to work easily. All work done on imperfect castings will be charged to the Foundry.

No of pieces.	Pattern mark.	REMARKS.

Price, per lb..... To be delivered.....

Patterns to be returned to us, when desired, free of expense, and in good condition; and stored, while in your possession, free of expense. No allowance for cartage.

STUB RETAINED IN STUB-BOOK.

NEWTON MACHINE TOOL WORKS.

Foundry Order No .. .. Philadelphia..... 18.....

To.....

No. of Pieces.	Pattern Mark.	Patterns Returned.	Weight.	REMARKS.

Price, per lb..... To be delivered.....

The drawing-room orders castings on blanks from a stub-book, printed on one side only, of the form given above. The size of the order sent out is 7¼ inches × 7 inches; the size of the stub retained in the book is 8½ inches × 7 inches.

This nominally settles the castings order. Those who are familiar with purchasing machine castings probably can tell, from their own experience, how near the assumption usually is to the fact in this matter.

From the order stub-book, a blank printed as below is furnished to the foreman in whose department the order falls. The size of this order is 6¾ inches × 10½ inches.

(TO FOREMAN.)

NEWTON MACHINE TOOL WORKS.

Order No..... Date..... Filled.....
Ordered by.....

To be marked
and shipped to.....

To be shipped via.....
Date to be shipped .. .. Our order No.....

Name of Machine:

This machine to have the following special features, specified in their order:

The office transcript preserved in the stub-book is 9 inches × 10½ inches, and is printed in the form given opposite.

(1)

NEWTON MACHINE TOOL WORKS.

Cut off when bill is made out.

Order No..... Date ..... Filled.....

Ordered by.....

Their Order No ... .
Their Req. No.....
Our Shop No.....
Our Bill No .....
Date to be shipped.....
Weight of Machine.....lbs.
Terms .....

To be marked and shipped to.....

To be shipped via.....

Price... .. Discount ..... Net Price .....

Name of Machine:

This machine to have the following special features, specified in their order:

Cut off when order is filled.

Large and small orders may follow each other. When two stub-books, one for large orders and one for small, are used, the order stub-book pages are printed on both sides, large order on one side, small order on the other; either large or small order blanks bearing the same consecutive number, thus appearing in regular sequence in the stub-book. The large orders receive a charge-sheet in the charge-sheet-pad (to be hereafter described), while the small orders carry their time-sheet with them, and do not appear in any subsequent record, the stub record transcript alone being sufficient for

SMALL ORDER—KEPT WITH WORK AND RETURNED TO OFFICE WITH WORK COLLECTING TWO TICKETS.

NEWTON MACHINE TOOL WORKS.

Order No..... Date..... Filled.....

Please do the following work. When finished, return this slip to foreman. Keep strict account of all time and material used. A piece-work ticket must be given with all work.

NAME	Date	No. of Hours	No. of Lbs.	MATERIAL

reference. The large orders are carried on, and made a matter of record finally in the shop cost-books.

The foreman keeps the small order until the work is done, when it is returned (filled) to the office with the work, and is transcribed on its stub on the office order-book. The size is 6¾ inches × 10½ inches, printed as shown on page 613.

The stub-book small order blank is 9 inches × 10½ inches, printed as below:

OFFICE TRANSCRIPT.

NEWTON MACHINE TOOL WORKS.

Order No. ..... Date..... Filled.....
Piece-work Ticket No..... Price..... Time.....

NAME	Date	No. of Hours	No. of Lbs.	MATERIAL.

This makes a very convenient method of obtaining both large and small blanks, as required, from one stub-book; not only is it an office convenience, but it avoids the liability of oversight. As there is but one order-book kept, there is no possibility of overlooking a small order.

When a large order is sent into the shop, a "charge sheet" correspondingly numbered is placed on the charge-sheet tablet, where it it is secured by a clip at the top, so that access can be had to any of the charge sheets, and where it is kept until the order is completed. This charge sheet is 11⅜ inches × 18 inches, and the right-hand column contains a list of the machine-shop tools and the occupation of the non-tool-using workmen. The sheet is ruled in red in 36 columns for hour-charges, with the tool and trade list at the left, and a 1-inch margin at the right, and is printed as shown on page 615.

This charge-sheet receives a daily transcript of the time-taker's sheet, which is a very peculiar affair, a distinct drawing-room emanation; while differing entirely from anything previously brought to the writer's notice, it seems to furnish an accurate time record with a very small amount of labor.

NEWTON MACHINE TOOL WORKS.

Shop No. ..... Name..... Black Figures for Journeymen
Red " " Apprentice Boys

Date.....189 NUMBER OF MACHINES BEING BUILT.....

Forge	
72" Planer	7
42" Planer	1
36" Planer	2
32" Planer	3
24" Planer	4-5
20" Planer	6
36" Lathe	10
32" Lathe	32
26" Lathe	12
Pulley Lathe	41
24" Lathe	11
21" Lathe	21
20" Lathe	14
18" "	15-16
16" "	17
16" "	
Nut Facer	
12" Lathe	22
Boring Mills	8-9
Hor. Floor B. M.	50
Boring Machine	36
" "	
10" Shaper	37
Slotter	38
Cutting-off Machine	39
Gear Cutter	26
12" Gear Cutter	51
Vertical Universal M.	24
Milling Machine	28
Worm Wheel Cutter	25
Drill Press	31
Plain Mill. Mach.	40
Machinists Floor Hands	F. H.
"	
"	
"	
"	
Laborers	L
"	
"	
Pattern Makers	23
Painters	P
Boxing & Skidding	B. S.

NEWTON MACHINE TOOL WORKS.

Name ..... Shop Name.....
Date of Order..... Date of Shipment.....
Number of Machines Built.....

	Lbs.	@	Per lb.		
Cast Iron					
Brass					
Forgings made outside					
Forgings					
Wrought Iron					
Machinery Steel					
Machinery Steel					
Cold Rolled Shafting					
Tool Steel					
Key Steel					
Forged Bolts, Nuts, etc					
Steel Castings					
Pulleys					
	Hrs.	**@**	**Per hr.**		
72" Planer					
42" Planer					
36" Planer					
32" Planer					
24" Planer					
20 ' Planer					
32" Lathe					
36" Lathe					
26" Lathe					
24" Lathe					
20" Lathe					
18" Lathe					
16" Lathe					
14" Lathe					
12" Lathe					
Slotters					
Boring Machines					
Boring Mills					
Pulley Lathe					
Shapers					
Cutting-off Machines					
Gear Cutting					
Milling Machines					
Vertical Milling Machines					
Tools not mentioned					
Hor. Floor Bor. Mach					
12" Gear Cutter					
Erecting					
Laborers					
Painting					
Skidding or Boxing					
Lumber used in skidding or boxing, and other material					
Sundry Bills, etc					
Drawings					
Patterns made outside					
Patterns made at shop					
Repairs made on patterns					
Traveling Expenses					
Cartage					
Total Cost of Machine					
Sold for					

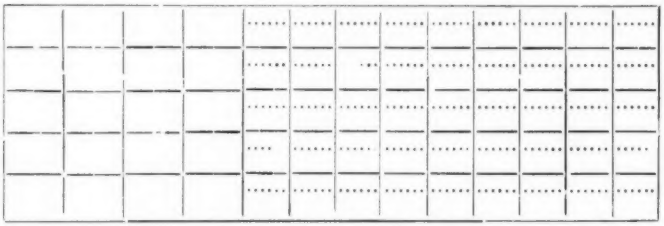
NEWTON MACHINE TOOL WORKS.

Built for.....
Ordered by.....
Order No.....

Shop Order No.....

Cold rolled shafting	Price	Forged Bolts, Nuts, etc.	Price	Bolts, Nuts, etc.	Price
Machinery Steel		Brass			
Cast Iron		Key Steel		Forgings	
			Sundry Bills, etc.		
Pulleys					

The time sheet itself is a ruled blank, both sides alike, 11½ inches horizontally × 19 inches vertically, ruled in ⅜-inch squares with quadrille red lines; from the fourth left-hand space heavy green horizontal lines divide the remaining squares of each line into a wide lower part and a narrow upper part, as partly shown below.



As both sides of the time sheet are alike, both sides are used in taking time.

To use this sheet, a thin drawing board, having a list of the names of the heads in each department along its left-hand edge, is used in connection with a T-square, as shown in the engraving herewith.

The T-square blade is wound with rubber bands near each end, so that it will not slide too easily on the paper. The time-sheet is pinned to the board, so that its horizontal lines stand opposite the names of the workmen in the list at the left-hand edge.

The first margin column on the time-sheet is "Regular Time" for the hand whose name is opposite. The next is "Over Time" for the same name. The third space is "In," and the fourth space is "Out." The narrow spaces between the red and green lines are for the tool-numbers.

The T-square blade has gummed to it a top line of symbols indicating different jobs of work or machines in progress, each of which, it will be remembered, has its "charge-sheet" on the charge-sheet tablet. The lower line of figures on the T-square blade contains all the tool numbers of the department. To take a workman's time, if he is not "out" and so disposed of at once by a mark in his "out" column, his time is first checked by a single inclined stroke as "regular time" or "over time." The job bearing the symbol "V" appears to have a large portion of the attention of the department, as it appears in no less than eight separate spaces. Any time charge against this "V"-job can be made in any of the time-sheet columns marked "V" on the T-square blade index, the charge being made in the line opposite the workman's name and under the machine-tool number in use by him, entered in the narrow space above the green

THE NEWTON TIME-SHEET BOARD.

line. Time is taken very rapidly with this odd arrangement, 58 names in one department being taken in less than 45 minutes. After the time-sheet is filled and removed from the board, it becomes a cryptogram, translatable only by being replaced on the time taker's board and read with the aid of the indexed T-square blade. Time charges are transferred from the time sheets to the charge sheet, until the job is completed. Then all the charges against the job are transferred to a loose, or "dummy," cost-book sheet, and, after this is made correct in pencil, it is transferred—in ink of course—to the fac-simile pages of the locked cost-book, and becomes one of the secret records of the house. The size of the double cost-book sheet is 23 inches horizontally × 18 inches vertically. The printing is given in full, the size being reduced.

It will be seen that the cost-book footings show every detail of the cost, with total cost and selling-price in the lower left-hand corner of the double sheet.

Every machine, as finished by the Newton works, has its cost sheet complete in the locked cost-books, and an estimate for a new machine materially differing from anything previously manufactured can be readily made from such a record, as the same elements appear throughout the whole line of Newton machines with surprising frequency.

The labor pay at the Newton shops is made on the Halsey premium system, previously mentioned in connection with the Builder's Iron Foundry, of Providence, R. I. This system is highly spoken of by the Newton management, its workings being considered eminently satisfactory.

THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN. I.

By W. P. Stephens.

THE development of yachting within the decade now nearing its end has been marked by many notable features, but the most conspicuous, at least to the general public, is the great increase of expenditure. The improvements in technical details, important as they are, have attracted less attention outside of yachting circles than the heavy and steadily-increasing cost, both of construction and maintenance, of the pleasure fleet, in its two divisions,—sail as well as steam. In view of the cost of such a yacht as Defender, whose use was limited to less than a dozen races, and of the later steam yachts, such as the Mayflower, Nahma, Varuna, and Margarita, it is natural to ask what benefits are derived by a nation at large from this expensive and luxurious sport.

It has already been the pleasure of the writer to lay before the readers of THE ENGINEERING MAGAZINE the claims of yachting, considered solely as a sport, to public consideration and support as an important adjunct to the sea-power of a nation.* Though indirect, the influences of a national system of yachting are both positive and powerful in fostering in times of peace a love of the sea and a pride in maritime supremacy that is of the highest value in case of war. This is especially the case in the United States, with a vast inland population to which the sea, the warship, and the torpedo, with their terrible menace to the whole nation in default of adequate protection, are but abstract conceptions. If nothing more could be urged in behalf of what some may look upon as a useless and expensive amusement, there would still be good reason for the generous support of yachting by the government and the people; but there are various direct and tangible benefits that appeal no less strongly.

In the emergency now confronting the nation, the United States has been found unprepared in several ways,—particularly in seamen to man the vessels and in one of the leading elements of a modern war fleet, the torpedo division, consisting of torpedo boats and torpedo-boat destroyers.

The new naval militia of the different States has placed at the service of the country a number of men, young, enthusiastic, patri-

* "National Supremacy on the Sea." ENGINEERING MAGAZINE, October, 1895.

otic, and of unlimited ambition to excel in naval work. Conceding that none, save a few of the older men, have seen actual service, and that many are still but landsmen, and placing the very lowest value on this corps as but raw material, it must still be admitted that it is the very best kind of raw material, and such as can be had from no other source. That there is to-day a naval militia is due solely to the American yachtsmen, with whom it originated and who to a great extent make up its actual membership.

In the matter of boats, the yacht fleet has been called upon, with excellent results from an emergency standpoint, as one of the very few available sources of supply. Within a little more than a month a mosquito fleet that promises to be formidable and effective has been created by the purchase and hasty conversion of some twenty of the largest and finest American steam yachts. The conditions which have called this fleet into being are peculiar, and, it is to be hoped, exceptional. While the torpedo boat and the destroyer have had for some years almost the first place in the naval programmes of even the smaller nations, like Japan, they have received so little attention in America that the bulk of her small fleet is still on the stocks, or even on paper, instead of in commission. With an extensive coast line to patrol, a valuable fleet of armed cruisers and battleships to protect from the threatened attack of the Spanish torpedo fleet, and the demand for many armed vessels of very light draft for the shoal harbors of the Cuban coast, the opening of hostilities found the United States with but eight torpedo boats in commission, and no torpedo-boat destroyers. While even the best of the converted yachts are inferior in many essentials to the torpedo vessels, at the same time they are of immediate practical value as scouts and patrol boats off the seaport cities, and for the Cuban service.

The question of the direct value of the steam-yacht fleet in case of war is one that has for several years engaged the attention of yachtsmen and the naval authorities, a paper on this subject, accompanied by a very interesting discussion, marking the inaugural meeting of the Society of Naval Architects and Marine Engineers in 1893. Thus far, however, it has not progressed beyond the stage of theory and speculation, and the opinions of the experts are by no means unanimous.

The consideration of cost must always be a controlling one in a naval programme; no matter how wealthy a nation may be, or how liberal its naval estimates, it must still get the most for its money. With much in common between the steam yacht and the naval despatch boat or torpedo-boat destroyer, the requirements of pleasure, nevertheless, are widely different from those of war; and a very large

proportion of the cost of the yacht goes into special appointments and elaborate furnishings that are worse than useless in case of conversion to war uses. Taking this into consideration, it seems that the best results, both as to cost and ultimate utility, are to be obtained by the direct construction of an adequate number of war vessels for the torpedo fleet, rather than by the proposed plan of coöperation between the government and the yacht owners, the former exercising a certain supervision over yachts during construction, and having the use of them for a portion of each year, and the privilege of purchase in case of need.

In the present case it may be said that the emergency is such as to bar the question of cost; if the converted yachts accomplish the work expected of them, the very great expense of their purchase at high prices, their hasty conversion, and the destruction of a large amount of costly furnishings, will be fully justified. We may look in the immediate future for some positive evidence *pro* or *con* on this question, but, even though it be decided against this use of the pleasure fleet, there is still another direction in which the steam yacht may be of practical utility in naval development.

The advances of the last few years have been largely in the department of torpedo warfare, and, in particular, in the important detail of the new type of torpedo-boat destroyer, as described in the preceding issue of THE ENGINEERING MAGAZINE. Important as have been the improvements in the hull design of large war vessels, in machinery, armament, and armor construction, still greater progress has been made in the perfection of the torpedo boat and the development of the torpedo-boat destroyer. In each of these types speed is the principal factor, the first sought of several essentials; and the search for high and still higher speeds gains new vigor with each advance. It is in this field of experimental research in high speed work that the steam yacht promises to be a most useful auxiliary to naval progress in the future, as it has already been in the past.

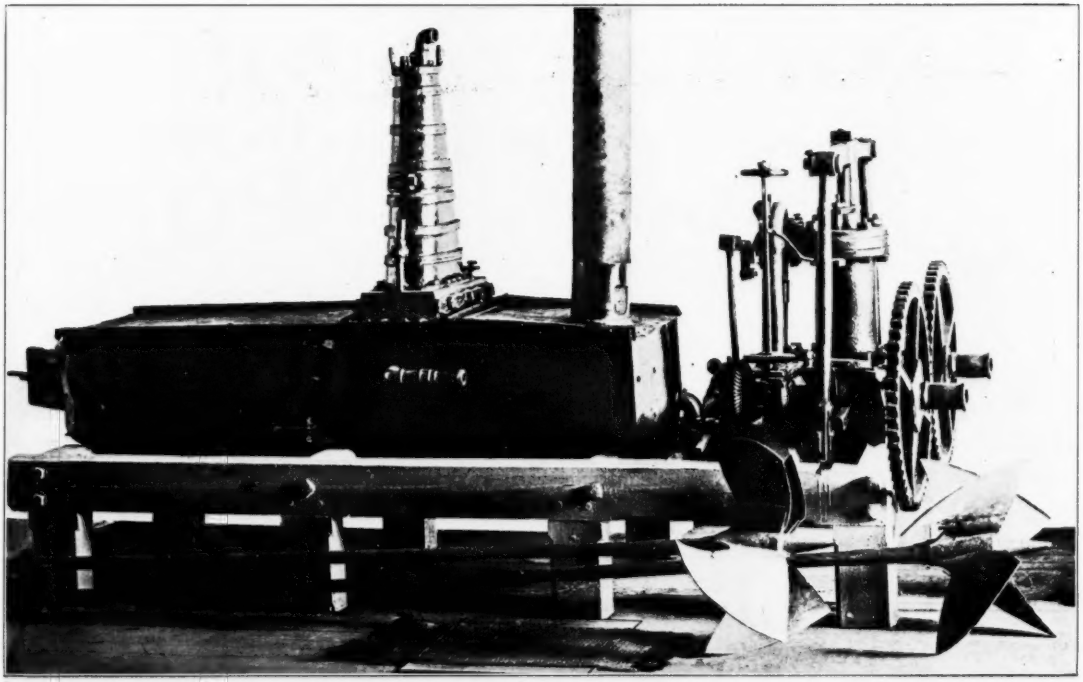
The position of the United States in relation to torpedo warfare is a very peculiar one. The torpedo and the torpedo boat are both of American origin, at least to the extent that the first successful experimental work was done in this country—by Fulton and others; both were first put to successful practical use in our civil war; and many important improvements have been made by Americans. At the same time, while the European nations have built up great fleets of torpedo vessels within the past twenty years, the government of the United States, up to five years ago, had done nothing, and even now is far behind the smaller foreign powers. In 1890, the year in which the first American torpedo boat, the Cushing, was placed in commission,

France possessed 210 torpedo boats, England 206, Italy 152, Russia 143, Germany 125, Spain 15, and even Japan had 24. At the beginning of the present year the United States had in commission eight torpedo boats and no destroyers, with twelve torpedo boats and three destroyers under construction. Since then two torpedo boats, the Morris and Gwin, have been completed.

The first suggestion of the high-speed yacht and the torpedo boat is to be found as far back as the date of the successful application of steam to navigation, at the beginning of this century. In the course of his extensive experiments in steam navigation, covering a period of nearly twenty years from about 1790, Col. John Stevens, of Hoboken, N. J., devoted much time and study to the screw propeller. Between the years 1801 and 1806 he experimented with a steam launch of his own design, running her on the Hudson river. The leading ideas of this craft not only were novel then among the many primitive experiments in steam navigation with paddles, oars, and the duck foot blade, but embodied the principles recognized in the engineering practice of this end of the century, though nearly half a century elapsed between the original experiments of Col. Stevens and the general acceptance of his ideas by marine engineers. Briefly stated, they are:

(1) The direct-connected engine, with high piston speed;
(2) The use of high pressure steam;
(3) The multitubular boiler;
(4) The short four-bladed propeller;
(5) The use of twin-screws.

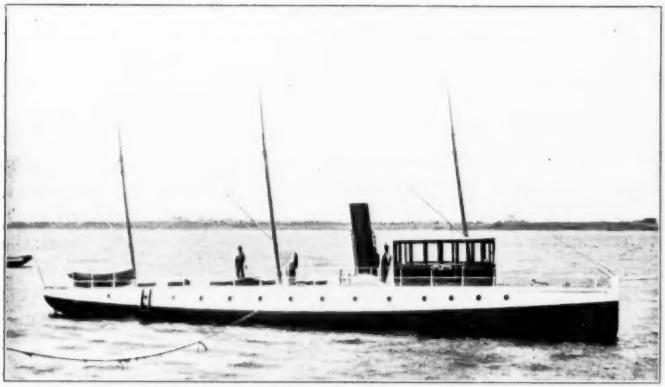
The progress which naturally would have resulted from the development of these advanced ideas was obstructed by the backward state of the arts at that time. The exportation of machinery from England was then prohibited by law, and this country boasted neither shops, skilled workmen, or even the crude machine tools then in use in England. The impossibility of constructing suitable engines caused Col. Stevens to abandon all efforts on the lines above indicated, and to confine himself to the slow-moving paddle engine, with steam of but two or three pounds above the atmospheric pressure. For nearly forty years after the first era of crude experiment, when the ocean steamship and the river steamer were commercial and mechanical successes, they depended on the box or shell boiler with steam of very low pressure, the slowly-moving engines indirectly connected to the shafts, and the paddle wheel instead of the screw. Col. Stevens and his descendants have been active agents in the cause of marine engineering down to to-day; but the immediate line of development on which the first real progress was made was very different from that indicated by this experimental launch. The first steam launch of which



ORIGINAL TWIN-SCREW ENGINE, BOILER AND PROPELLERS OF COL. JOHN STEVENS,
Built in Hoboken, New Jersey, in 1804.

there is any record in America, and presumably the first built, was the Sweetheart, designed by Mr. Charles H. Haswell, of New York, and built under his direction, at the Brooklyn navy yard, in 1837. She was 35 feet over all, 4 feet 3 inches beam, 3 feet depth of hold. Her engine was a miniature of the ordinary walking-beam type, then in general use and still familiar on ferry-boats, the cylinder being 4 inches diameter and 12 inches stroke, taking steam from a horizontal fire-tube boiler. The two paddle wheels were 3 feet 6 inches in diameter. The boat made a speed of 5½ miles on the Hudson and East rivers.

For many years after this experiment nothing was done in the same direction. During the civil war some steam launches of crude and primitive build were used by the navy, some even carrying a spar projecting twenty feet or more forward of the bow, attached to which was a torpedo. The hulls were merely those of the rowing cutters and pinnaces of the day, and the engines were apparently very inefficient, as the ordinary rowing boats, propelled by oars, were fitted with spars and used with the steam launches. After the war no effort was made to improve the navy launch or to produce an efficient torpedo boat, though early in the seventies it was proposed to build some small vessels of especially light construction and high power from which a speed of 15 knots might be realized, fitting them for torpedo work. One of the first to achieve a notable success in the line of steam launches was the firm of John I. Thornycroft & Co., of Chiswick, England, which in 1870 launched the steam launch Ariel. This craft was built of bessemer steel, with plates $\frac{1}{16}$ of an inch thick, her dimensions being 45 feet 6 inches over all, 45 feet lwl, 5 feet 6 inches beam, 3 feet 3 inches depth of hold, and 2 feet draft. Her engines had two inclined cylinders, 5½ by 6 inches, making over 400 revolutions. The rudder was in two parts, the shaft passing through it, with the screw well astern of the vessel. Mr. Thornycroft made only the modest claim of 14 miles, but even this was accepted with marked skepticism. After experimenting with another launch, the Swallow, in June, 1871, the firm made an indelible mark in the history of the steam launch by the launching of the Miranda. This craft was 50 feet over all, 45 feet 6 inches lwl, 6 feet 6 inches extreme beam, 5 feet 9½ inches beam at lwl, 1 foot 9 inches extreme draft, and 2 feet 6 inches draft at heel of shoe. The displacement was 3.72 tons; the hull, plated with $\frac{1}{16}$ to ⅛-inch steel, weighed 1.10 tons, while the machinery, with steam up, weighed 2.05 tons. The two cylinders were 6 by 8 inches, and the boiler, of the locomotive type, was 6 feet long and 2 feet 8 inches in diameter, with steam at 100 to 125 pounds. Mr. Thornycroft's promise of 18 miles was more than realized in the ex-



THE STILETTO, BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

haustive trials made by Sir Frederick Bramwell in 1872, when a speed of 16.1 knots was made, with 555 revolutions and 55 i. h. p.

This achievement led, in 1873, to an order from the Norwegian government for the first veritable torpedo boat, with a guaranteed speed of 16 statute miles in an hour's continuous run. The Rasp, as she was named, was 57 feet over all, 7 feet 6 inches beam, 3 feet draft, and about 7.50 tons displacement, with compound surface condensing engines of 90 i. h. p., a locomotive boiler, and the Thornycroft wheel. Forward and aft of the machinery space were open cockpits, with movable hatches of thin steel, while forward of the boiler was a steering compartment with a low conning tower of steel, with a protection of $\frac{3}{16}$-inch steel plates over the machinery. With an average of 85 pounds' pressure, the Rasp made 17.22 miles in a run of one hour on the Thames.

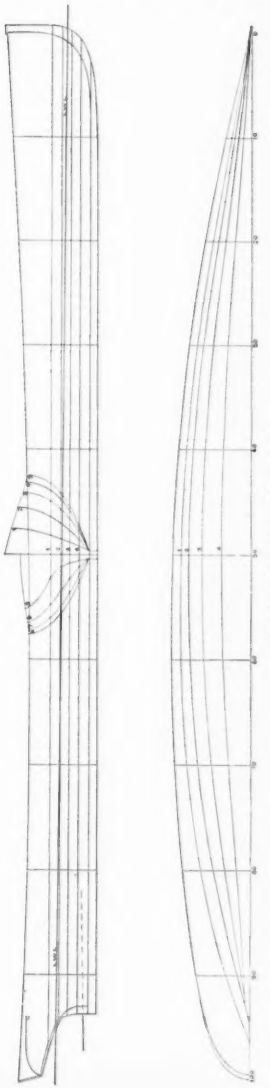
After this successful venture on the part of Norway, Sweden and Denmark followed with similar orders; then Austria, France, Holland, and Italy; but not until 1877 did the British government place its first order—for the Lightning, 84 feet over all, 81 feet lwl, 10 feet 10 inches beam, and 5 feet draft, showing 19.4 knots when light, on her preliminary trial. In the Rasp and the succeeding boats the torpedo was towed astern, and so steered as to sheer clear of the boat when launched against a hostile vessel.

Important as were the experiments with the Miranda and the first torpedo boats, they seem to have had little influence on the service launch of the British navy, which, up to 1879, was fitted with the ordinary high-pressure non-condensing engine. After that date came the surface condenser, compound engine, and forced draft.

In the United States the first steam yachts and small launches were introduced about 1870. The American yacht list of 1874 enumerates 22 steamers, from the Ideal, 130 feet over all, 110 feet lwl, built in 1873, down to small open launches, none built prior to 1869. The Herreshoff Brothers, of Bristol,—later the Herreshoff Manufacturing Co.,—were among the first builders of successful launches, their work, even at that early day, being marked by that originality of design and lightness of construction which was the distinguishing feature of Defender. From the first they paid little attention to the conventional methods of hull construction and the reduced fac-similes of large engines which made the ordinary steam launch of the time a slow, heavy, and clumsy affair, but worked after direct and original methods for the main ends in view—lightness and speed. They turned out launches for yachtsmen and also for the navy, and small steam yachts; and in 1876 they built for the United States government its first torpedo boat. The Lightning was an open wooden launch, 58 feet long, fitted with spar torpedoes, and showing about 17 miles on her trials. Nothing more was done by the United States, but in 1878 an order was received at Bristol from the British government for its second torpedo boat. This craft departed widely from the ordinary launch type in model, and possessed some remarkable features. She was 59 feet 6 inches long, 7 feet 6 inches beam, with a wooden frame and ⅞-inch white cedar planking up to the water-line. Above this the skin was of steel, up to the gunwale, with a crowned deck of steel extending down to the gunwale, the general appearance being similar to Stiletto, page 627. The compound engine had cylinders 6 and 10½ inches by 10 inches. In accordance with a theory then in favor,—that the best position for the wheel was well under the hull,—the wheel was below the keel at a distance of about two-thirds of the length from the bow. The shaft was allowed to take a natural sag from the engine, placed well forward, curving down through the keel to the propeller. Outside the hull it was carried in a hollow keel or fin built of two plates of brass, with sufficient space between for the shaft and bearings. The constant strain due to the twisting of the shaft with every revolution caused it to break frequently.

By this time, 1878, the importance of the torpedo boat as one of the essential implements of modern warfare was recognized throughout Europe, and under the active encouragement of all the continental powers such men as Thornycroft, Yarrow, and Normand were raising the record of speed, with added fighting efficiency, at each fresh attempt. On the other side of the Atlantic, however, the torpedo boat received no attention from the government after the first feeble effort in the Lightning. Fortunately, however, there were private individu-

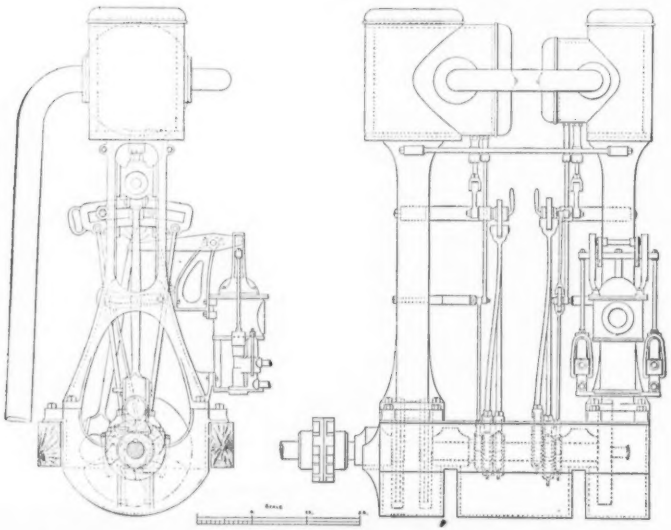
als who were sufficiently interested in the subject of high speed to offer the necessary encouragement to designers and builders; and in 1878 one of these, Mr. W. H. Graham, of Baltimore, placed with the Herreshoffs an order for a high-speed steam yacht. This yacht, the Leila, was 100 feet over all, 95 feet 5 inches lwl, 15 feet 4-inches beam at deck, 11 feet 9 inches beam at lwl, 5 feet 6 inches depth of hold, and 4 feet draft. The hull was of wood, with the exception of angle iron frames, the planking being of yellow pine sheathed with copper. The angle irons were 1½ by 2¼ inches, spaced 15 inches, with planking 1¼ and deck $1\frac{3}{16}$ inches. The compound engine had cylinders 9 and 16 inches by 18 inches, with a four-bladed screw of 4 feet 7 inches diameter and 8 feet pitch. The boiler was of the Herreshoff double-coil type, 7 feet in diameter and 8 feet high. The Leila was the subject of exhaustive experiments by three naval engineers in 1880, who reported very favorably as to the model, construction, engines, and, in particular, the coil boiler.



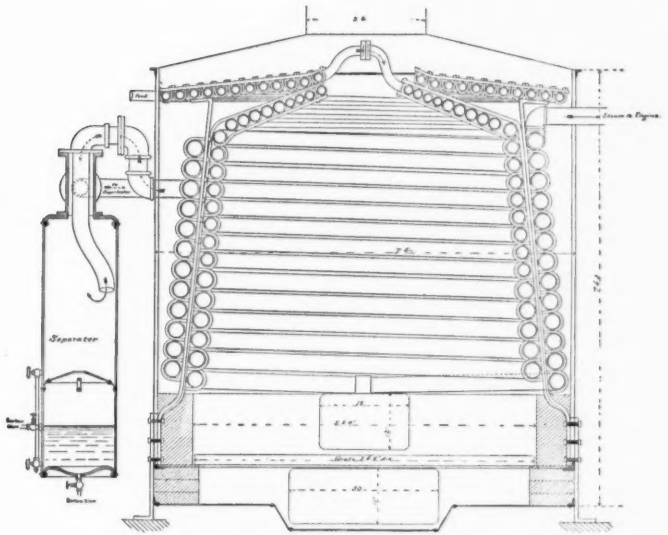
THE LINES OF THE LEILA.]

In 1880 the Herreshoffs turned out a larger yacht for Mr. Graham, the Gleam, of 120 feet over all, 110 feet lwl, 16 feet beam, and 5 feet 8 inches draft, with similar engines, enlarged to 10½ and 18 inches by 18 inches, and a boiler 5 by 8 feet, of 192 h. p. This vessel also proved successful. These were followed by many steam yachts, pleasure launches, and naval launches for the United States and foreign governments, all marked by lightness of construction

and speeds suitable to the intended use. In 1884 they built a 35-foot launch, of 7 feet 6 inches beam, with compound engines of 50 h. p., for the steam yacht Atalanta, the little boat showing a speed of 12½ knots. The following year the firm turned out, to its own account, one of its most notable successes, the steam yacht Stiletto, 94 feet over all, 90 feet lwl, 11 feet 4 inches beam, 8 feet depth of hold, and 4 feet 6 inches draft, with a displacement of 28 tons. Like the English torpedo boat already mentioned, the model showed a marked departure from the conventional steam yacht and in the direction of the modern torpedo boat, the deck having a strong reverse sheer and being joined to the hull proper by inclined sides. The two cylinder compound engines were 12 and 21 inches by 12 inches, with annular valves cutting off at about ⅝ of the stroke, with about 450 revolutions. The boiler was of the Herreshoff coil type, 7 feet square, with 615 square feet of heating surface, the working pressure being 160 pounds and the h. p. 450. The hull was of wood, with oak keel, stem, and sternpost, light bent frames of oak spaced closely together, and a double skin of white cedar and pine. The wales were of oak, heavy, and moulded from the solid. The entire hull was light, the upper works and deck especially so. The hull was divided into six water-tight compartments. Very little was heard of the yacht during



ENGINE OF STEAM YACHT "LEILA," HERRESHOFF MFG. CO., BRISTOL, R. I.



COIL BOILER OF THE "LEILA," HERRESHOFF MFG. CO., BRISTOL, R. I.

her construction, but in June, 1885, she made a sudden *début* in New York waters in an impromptu race against the famous Hudson river steamer, Mary Powell, for so many years the recognized standard of speed on the river. Though entirely unofficial, and not timed, this trial demonstrated the speed of the new craft; and it was verified in the following month, in the second annual regatta of the American Yacht Club. In this race the course was from off Larchmont down Long Island sound to New London, a distance of 80 nautical miles, the fleet of starters numbering sixteen, the largest being the big cruising yacht Atalanta, of 228 feet lwl, a vessel specially designed for speed in her class. The Stiletto covered the course in 4 hours, 49 minutes, and 54 seconds, an average speed of 16.5 knots, beating the Atalanta by 4 minutes 4 seconds. She was used by her builders until 1888, when she was purchased by the government and attached to the Newport torpedo station as a practice boat, in which service she remains.

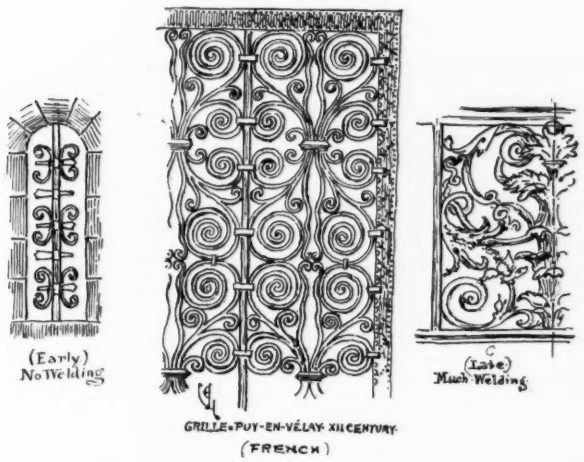
ARCHITECTURAL WROUGHT-IRON ORNAMENT.

By W. Martin Aiken.

IRON has been known and used for about five thousand years. Tubal Cain, son of Lamech and Zillah (only seven generations from Adam), was "the instructor of every artificer in iron and brass." The British Museum contains a piece of iron from an inner masonry joint in the Pyramid of Cheops, the oldest known edifice built by the hand of man. In early history the power and skill of the blacksmith was deified in the person of Hephaistos by the Greeks, or of Vulcan by the Romans, and volcanoes were supposed to mark the spot below which, in the nether world, he worked at his forge in shaping the thunderbolts of Jove or the armor of Mars. Dr. Schliemann, in his excavations at Mycenae and Troy, found numerous specimens of wrought iron, some of which may now be seen in the museum at Athens: Greek painted vases show anvils, hammers, pincers, and bellows; and welding is said to have been invented by Glaucos, of Chios, 600 B. C.

In the Kirchlerian Museum, Rome, and National Museum, Naples, are many examples of Roman iron work used as arms, utensils, and house-furnishings. Iron rings among Romans were insignia of freemen, and, though weapons and articles for use were of iron, those for ornament were generally of bronze or brass. Ordinary labor was performed by the slave, skilled labor by the freeman. Things of artistic finish were hardly ever of iron; consequently the very early iron work of museums can not compare in subtlety of design or nicety of execution with bronze, brass, or ceramics of the same period.

The Gauls of the northern provinces were well acquainted with the use of iron, though they were interrupted in its development by the invasions of the fifth and sixth centuries. Among them it was diverted to warlike uses rather than to the arts of peace. Eastern and western conquests and commerce with Syria, Persia, and India, as well as the Crusades, brought to light many hitherto unknown uses of this metal. In those days, when every man's hand was against his neighbor, and when "might made right," there were grilles at the windows and bars at the doors. The windows at first were small, and very seldom was glass used in them, the substitute (if any) being cloth or the skins of beasts. The opening was protected by parallel or interlacing bars, or, later, by some pattern of scroll work or inter-



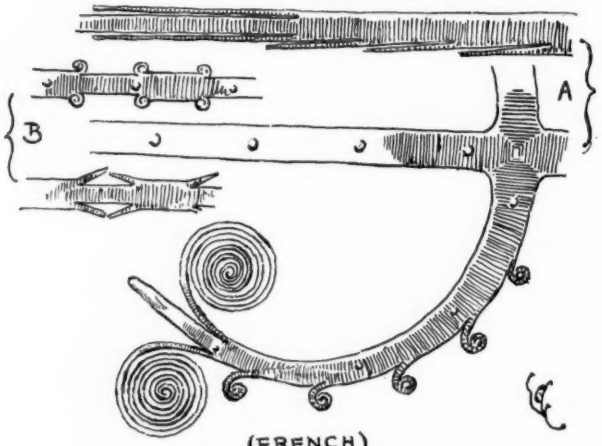
twining branches of wrought iron. Afterwards, when men began to build larger and better houses, balconies were constructed from windows of upper stories, and, where the sun was hot, there were rings or sockets for holding the frames of awnings.

In the midst of this perpetual warfare, sometimes as a result of it, a church would be built, and upon it the best labor would be expended, with the choicest materials to be found. As early as the tenth century a beautiful rood screen was made for the cathedral of Auxerre, in France, which was described in the chronicles of the monks of the time as being "of marvelous delicate workmanship."

In the twelfth and thirteenth centuries the blacksmith who could fashion an elaborate hinge was accounted the master of his trade, as in Venice was the bricklayer who could build successfully the fantastic chimney-tops of that city. At that time bar and sheet iron were not to be found already manufactured, and the use of the file was not known; but the paucity of materials and tools brought about great skill in the use of the hammer, and, as, with the gradual introduction of mechanical appliances, many difficulties, especially of large or intricate pieces, were overcome, by degrees manual dexterity declined. The working in iron possesses in common with painting and sculpture the charm of proceeding directly from the hand of the originator; the personal element is pronounced.

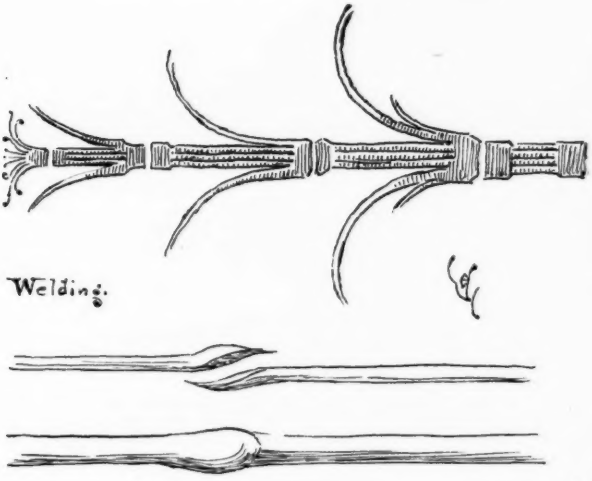
Doors were first made of hewn timber of single thickness (with battens), or of two or more thicknesses, and, as every house-holder

was liable to be attacked at some time, the hinges performed the double duty of revolving the door and of strengthening it. The early forms of hinge were: (1) the shoe (into which the upper and lower inner angles of the door were fitted) and the pintle, which were housed into sill and lintel; (2) the double strap (passing across each face of the door, forming a loop at the inner edge) and the gudgeon, secured in the jamb, over which the strap fitted. Later, in Germany



(FRENCH)
ROMANESQUE

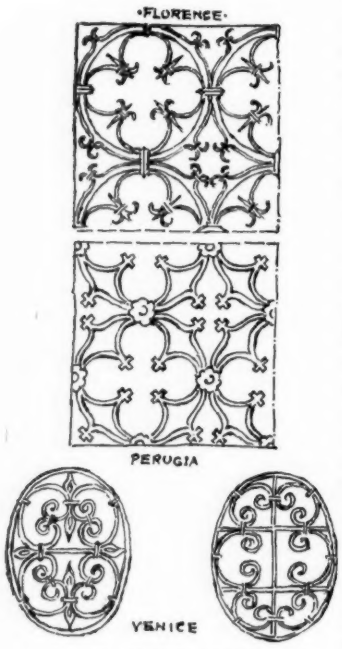
and northern France, the single strap, on one face only, was used, and in central and southern France the C shape; gradually the shapes were combined and others were introduced, a favorite type being the horizontal stem with curving scroll-like branches in France and with angular branches in Germany. The vine or the acanthus generally supplied the motive for this work; but in the thirteenth century certain independent characteristics began to appear in German work, some with very elaborate branching strapwork, ending in vines or fleurs de lys,—derived, but differing, from the French,—as seen in Magdeburg, Marburg, and elsewhere. Among the best known and most decorative of this period in France are the hinges on the Porte Ste. Anne (to right of centre on west front), of Notre Dame, Paris, which were considered so wonderful that it was said by some that the maker had bartered his soul to the devil in the making of them, and by others that he was the devil himself. If there



(FRENCH)

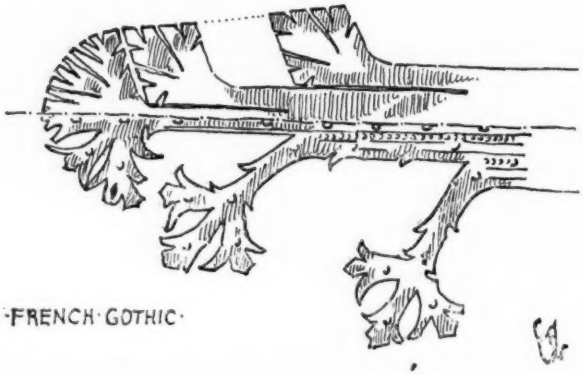
are those who consider that too many curvilinear forms in wrought iron indicate a weakness, lack of virility, or inconsistency of design with material, and that the decorative arts have a stronger claim to our respect when their beauty proceeds from their fitness; to them it may be said that the blacksmiths of Auvergne seem to have felt this, since they have used more angular and robust forms among the curves.

Towards the end of the fourteenth century, Germany excelled in wrought-iron work, which was peculiar in being "repoussé" and so thin as to resemble sheet iron, often taking certain forms based on the thistle, and frequently secured to the wood over skins or heavy cloth, and generally painted red. This was not used in France until the fifteenth century. With the disappearance of the tongued and grooved woodwork of mediæval doors, the long strap hinge and the other decorative stiffening bands gave place to the butt hinge used on the framed and panelled joinery of the Renaissance. The employment of iron work has always been intimately connected with and fostered by architecture; so, when one architectural style was replaced by another, the fashion of iron work was likewise affected. These results were by no means the same in different countries. In Italy, for instance, where Gothic principles were neither understood or appreciated,



·ITALIAN·RENAISSANCE·

wrought-iron work did not show the same sympathy with the Gothic style that was shown in France or Germany, while its wrought-iron work of the Renaissance showed certain peculiarities of marked and very diverse character. The grilles at the entrance of St. Mark's, Venice, were of cast bronze of a Byzantine scale pattern, and were the source of inspiration for many other grilles; but, when they were imitated in wrought iron, much labor was saved by turning up the ends of the scales (making scrolls of them) and forming almost endless combinations by placing them at many different angles next each other. Many Italian grilles are based upon the quatrefoil and these scrolls, small or large, play an important part in the Renaissance as in the earlier work. A balcony in the Palazzo Bevilacqua, Bologna, is a beautiful example of the continuous use of the small scroll; the grilles surrounding



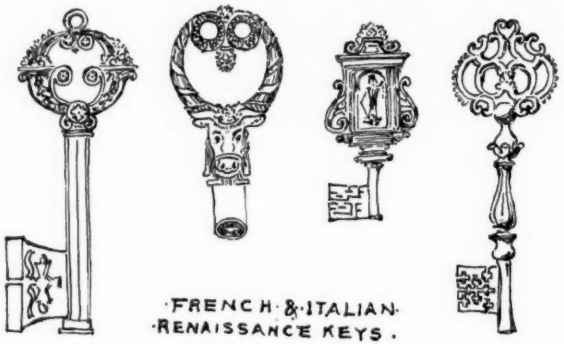
·FRENCH·GOTHIC·

the tombs of the Scaligeri (with the ladder in each quatrefoil) in Verona (1375), and certain others in Siena, Florence, Prato, and Perugia, show the application of the quatrefoil. Many churches in Venice contain lamps hanging from the ceiling by chains of great delicacy and variety of design, and there are myriads of bridges and balconies and fan-lights throughout the city. In Siena and Florence are several cressets, or torch-holders, and banner-holders, beautifully modelled and very skilfully wrought. Of door-knockers there are many Italian examples. An antique found at Capua is the head of Medusa; a later one from Ferrara is David with the head of Goliath, surrounded by two lions. Lions, lion's head (with ring), dolphin, and the human head, or figure, were favorite subjects.

It is rather surprising that, from an age when so much of this character of work was done, no drawings of iron work have come down to us, especially when so many for gold, silver, and bronze, have been preserved. The influence of Vitruvius on Italian architecture was a serious blow to architectural wrought iron; but there were no remains

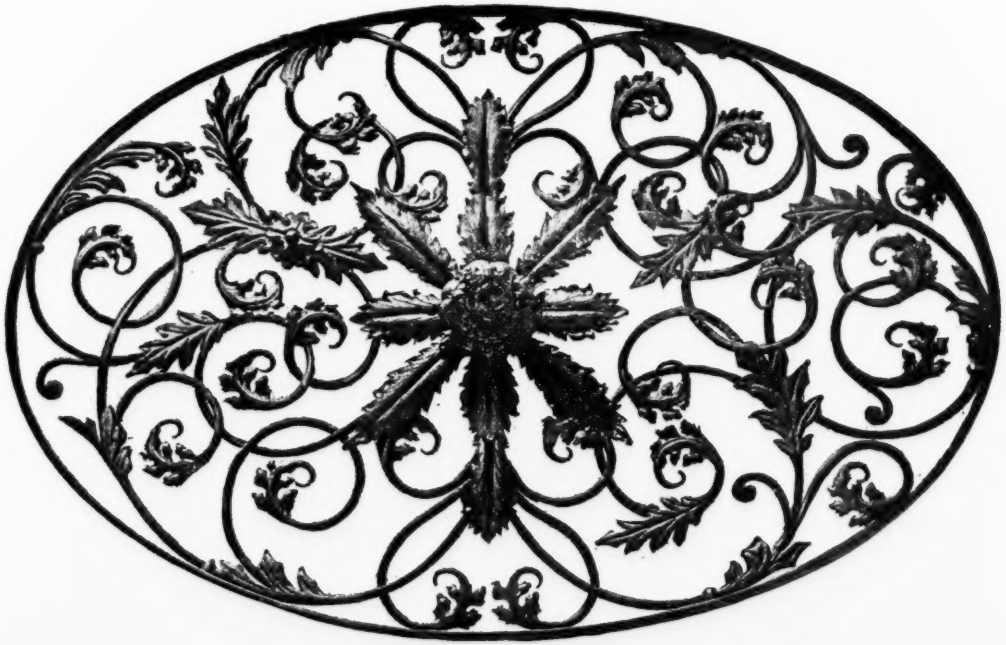
of iron work existing in Rome, and not until Palladian architecture had become somewhat degenerated did the window grilles, which had been of square or round bars set in rectangular or lozenge shape, begin gradually to curve outwards, and then to assume other fanciful forms. Little architectural work save wall anchors, finials, door trimmings, and kitchen utensils, was made under the earlier Renaissance, although arms and armor were fashioned more beautifully than ever.

In Austria there may not be so many notable examples as in Germany, France, northern Italy, or Spain, but among them are a few which are remarkable, such as the grille surrounding the cenotaph of the Emperor Maximilian at Innsbruck, which possesses some of the peculiarities of the work of southern Germany,—large and frequent scrolls, many turns, little leafage, mostly round iron, bars passed through each other, and not welded, diagonal rods passing through scrolls. An excellent example of this "threaded" work is seen in a balcony from Nuremburg. Very little early work remains in Belgium; the wealth of the country caused it to disappear under the fre-



FRENCH & ITALIAN RENAISSANCE KEYS.

GERMAN LOCKS.



OVAL GRILLE. THE YALE & TOWNE MFG. CO.
Note the balance of masses without identity of the two sides.

HAND FORGED FINIAL. JOHN WILLIAMS.

quent demolition and rebuilding of the time. Only Bruges and Brussels possess many interesting examples. The reproduction of the forms of fruit, flowers, and garlands was brought to great degree of perfection in after years. The Matsys family, of Louvain, gave to wrought-iron work very great distinction, and the well-cover at Antwerp (1470) is worthy of high praise.

Spain first introduced Flemish grilles for its churches in the sixteenth century, when that country was rejoicing in great commercial prosperity. The Queja (as the choir screen was called) was often more than thirty feet in height, and was formed of rods, some of them twisted, and of long, attenuated balusters, arranged in panels surmounted by a deep frieze of leaf-work and ending in very rich crestings, consisting of armorial bearings, figures, and scrolls. Great taste and refinement were shown, and much splendor was obtained by frequent gilding.

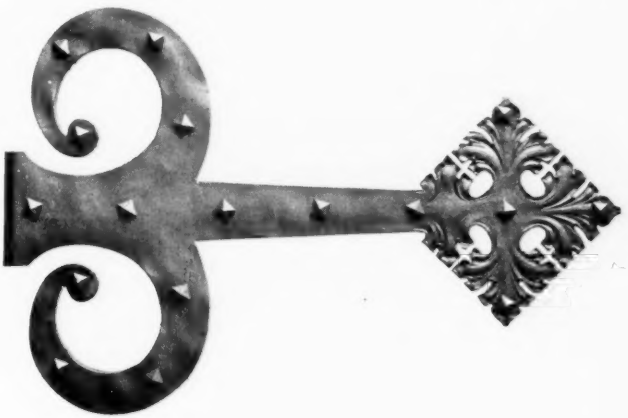
The plant forms were often borrowed from those of the new world,

HAND FORGED RAILING. DESIGNED BY RUTAN & RUSSELL; EXECUTED BY WINSLOW BROS.

ROMANESQUE HINGE STRAPS. THE YALE & TOWNE MFG. CO.

such as the aloe, agave, and yucca. No countries so abound with wrought-iron grilles, fences, and gates, at the present day, as Spain and Portugal, where frequently vineyards are closed by gates of excellent design and workmanship.

In England wrought iron was as well developed in the tenth cen-



GOTHIC HINGE STRAP. THE YALE & TOWNE MFG. CO.

HAND FORGED PANEL. JOHN WILLIAMS.

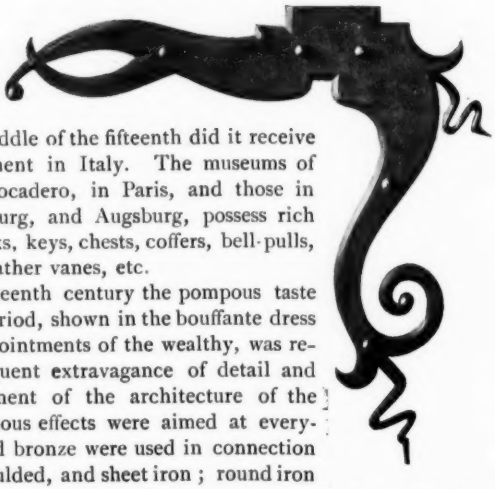
tury as at any period up to the thirteenth century. The crescent form of hinge is to be found on doors of the old churches of Kent, Yorkshire, Essex, Norfolk, and Suffolk. A very considerable proportion of the surface of many of these early doors was covered by iron work, which had much of the thickness of metal of the French, with the angular branching and quadrated leafage of the German work, and the habit of placing a scarlet lining between the wood and iron, which existed as early as the tenth century, antedates the German. Grilles in English churches may almost be counted on the fingers of the two hands, but tomb rails were very numerous in church interiors down to

GOTHIC HINGE STRAP. THE YALE & TOWNE MFG. CO.

about the middle of the seventeenth century. After the fifteenth century the work became uninteresting and not very good. The collection in the South Kensington Museum, while containing much interesting material, is extremely meagre in English examples.

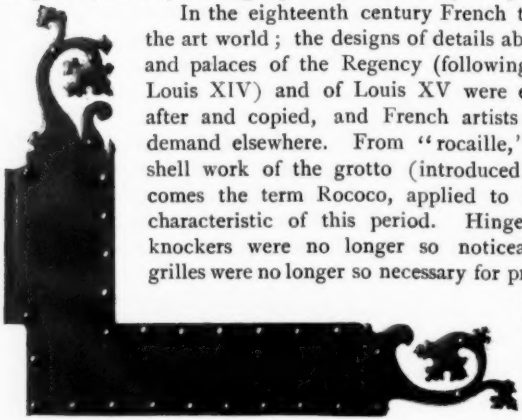
In the middle ages the trade of the blacksmith was raised so near to the highest point of art-smithing that, with the coming of the Renaissance, much of the clumsiness and angularity of the Gothic disappeared, and, instead, a simplicity and refinement appeared, to give such beauty of form as has never before been seen. The casting of iron began to be known at this time, though its use was comparatively limited. At this time also the balustrade was developed architecturally; independent iron gates were not used commonly until the time of the Renaissance. The screw, for securing hardware in place, had been in use only since the end of the fifteenth century, although the industry of hardware was well developed in France, Switzerland, Bohemia, Bavaria,

WROUGHT IRON ANDIRONS, WINSLOW BROS.



and along the borders of the Rhine in the fourteenth century,—not, however, until the middle of the fifteenth did it receive much encouragement in Italy. The museums of Cluny and the Trocadero, in Paris, and those in Munich, Nuremburg, and Augsburg, possess rich collections of locks, keys, chests, coffers, bell-pulls, sign brackets, weather vanes, etc.

In the seventeenth century the pompous taste of the Baroque period, shown in the bouffante dress and luxurious appointments of the wealthy, was reflected in the frequent extravagance of detail and overloaded ornament of the architecture of the time, and sumptuous effects were aimed at everywhere. Brass and bronze were used in connection with wrought, moulded, and sheet iron; round iron gave place to square; leaves, volutes, rosettes, garlands, cartouches, initials, and coats of arms were freely used. Grilles required sometimes more than half a dozen sections of bar iron; rich effects were concentrated at prominent points, the field often being filled with parallel bars or lattice work; pediments, panels, and pilasters (with cap and base) were skilfully reproduced and used on a large scale in and about the chateaux and churches frequented by the princes of the period, this style being especially affected by the Jesuit churches.



In the eighteenth century French taste regulated the art world; the designs of details about the castles and palaces of the Regency (following the death of Louis XIV) and of Louis XV were eagerly sought after and copied, and French artists were in great demand elsewhere. From "rocaille," the rock and shell work of the grotto (introduced from Italy), comes the term Rococo, applied to the decoration characteristic of this period. Hinges, locks, and knockers were no longer so noticeable; window grilles were no longer so necessary for protection; but sign-brackets, balcony-railings, and balustrades were more gener-

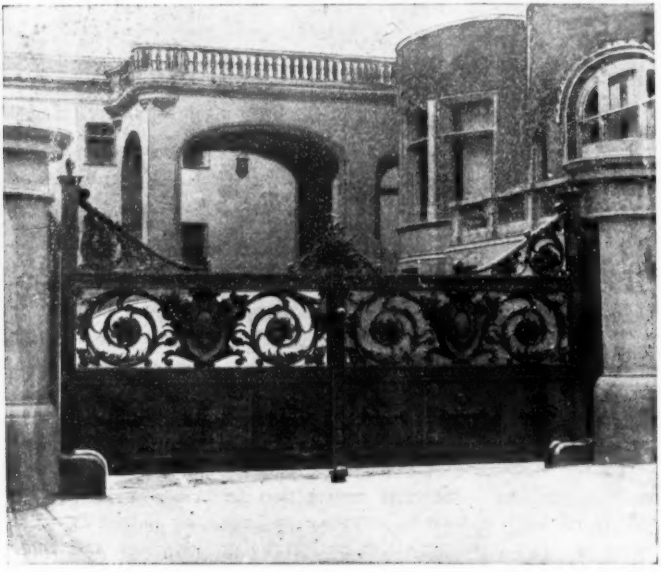
WROUGHT DRIVEWAY GATE. WINSLOW BROS.

ally used than ever, and parks, both large and small, were handsomely railed in, and provided with magnificent gates.

In the early part of the present century ornamental iron work received its first substantial recognition in America in the frequency of lamp standards, entrance railings, and balconies in the best houses in the eastern cities, and in the grilles, gates, and balconies of those in the south, which showed traces in New Orleans of French and Spanish influence, and in Charleston of English influence.

WROUGHT IRON PANEL. WINSLOW BROS.
From original in Entrance Gates, Maisons-sur-Seine.

For fifty years there has been but little wrought iron used, until recently; but in the meantime the gamut has been run in cast-iron from the rustic border of the flower-bed, the deer on the grass plot, and the lion at the door of the suburban cottage, to the five-storied warehouse, more than two hundred feet square, which, on its completion (about 1874) was the best-known dry goods house in



ENTRANCE GATES. WINSLOW BROS.

SEMI-CIRCULAR GRILLE. THE YALE & TOWNE MFG. CO.

America. Since the great fires of Chicago and Boston, and between the time of the Philadelphia Exhibition in 1876 and that of Chicago in 1893, there has been very great improvement in both cast and wrought iron.

Much of this improvement was due to the general and increased prosperity of the country, to the foreign training of the architects, and the patience, ingenuity, and skill of the workmen. To such men as the late H. H. Richardson and the late R. M. Hunt, America is indebted for the introduction and evolution of many beautiful designs, and to Messrs. John Williams and A. B. Stillman, of New York, and Winslow Bros., of Chicago, specially in wrought iron, and Yale & Towne, in cast-iron and bronze hardware, for the execution of work that will rank worthily with much of the best in foreign lands. Mr.

FORGED KNOCKER. THE YALE & TOWNE MFG. CO.

WROUGHT IRON ELECTROLIER. WINSLOW BROS.

stone balustrades to the steps and balconies of many New York houses has given an opportunity for renewing them, and the demand for greater elegance at the principal entrance has let to the removal of the outer vestibule doors, the replacing of which has produced some very interesting work.

In the Metropolitan Museum is a valuable collection of excellent Richardson's hinges of Trinity Church, Boston, of Sever Hall, Cambridge, and of his various libraries, and the grilles of four residences in Washington ; Mr. Hunt's Havemeyer fence and gates on Madison avenue, New York, and the grille at the entrance of the W. K. Vanderbilt house at Newport, with the multitude of their balconies, railings, and lamp standards, are known and admired all over the country.

The gradual decay of brown

WROUGHT LAMP. JOHN WILLIAMS.

examples of European work, presented by Mr. Henry Marquand.

Oxidation is the omnipresent and irresistible enemy of iron-work, and many devices have been employed to overcome it. Gilding has been often used to excellent advantage, but, on account of its expense, can never become general. The Bower-Barff process is also used for hardware and small pieces, but has its limitations Painting is the most universal form of protection, but with successive applications the density of the pigment, used to give body and color to the oil or other vehicle, certainly detracts from the beauty of finely wrought surfaces and edges.

WROUGHT LEAF GRILLE. WINSLOW BROS.

There has never been written a full and complete history of iron work, giving its contemporaneous development in all countries; but, as the subject has always been an interesting one, there are many *brochures*, encylopœdic articles, and folios prepared at different times and in various lands. The following are among the most important publications, though, besides these there are countless illustrations of iron work intermingled with the drawings and sketches of architectural publications.

Handbook of Art Smithing . . . . *Franz Sales Meyer.*
Architectural Iron Work . . . . . *Wm. J. Fryer.*

Examples of Decorative Wrought Iron Work, seventeenth and eighteenth centuries . . . . . *D. J. Ebbetts.*
Iron Work (South Kensington Handbook) *J. Starkie Gardner.*
Transactions of Royal Inst. British Architects (1890–'91–'92) *J. Starkie Gardner.*
Smithing and Ironmongery . . . . *Gwilt's Encyclopædia.*
Architectural Wrought Iron (plates) . . . *W. W. Kent.*
The Iron Age (weekly) Nos. from June 8th, to July 6th, 1893.
"Grille," "Heurtoir," "Serrurerie" (Dictionnaire de l'Architecture) . . . . . *Viollet le Duc.*
Many Articles in Dictionnaire du Mobilier. . *Viollet le Duc.*
Serrurerie (Dictionnaire d'Ameublement) . . *Henri Havard.*
Serrurerie (Grammaire des Arts Decoratifs) . . *Charles Blanc.*
Revues des Arts Decoratifs, L'Art pour Tous, Motifs divers de Serrurerie } Articles collated and bound together. } *Serials.*
. . . *César Daly.*
Fidelle ouverture de l'Art de Serrurerie . . *Mathurin Jousse.*
Serrurerie du Moyen Age . . . *Raymond Bordeau*
Modèles de Serrurerie, (Plates) . . *Leconte.*
Modèles de Serrurerie . " . . . *Bury.*
Les Arts du Metal . " . . *Giraud.*
Artistic Wrought-Iron Work " . . *Fonteyne.*
Wrought-Iron Work in the Style of Louis XV. *François de Cuvillies.*
Histoire du Luminaire . . . *Henry Réné d' Allemagne.*
Die Schmiedekunst.
Alte Kunstschmiede-Arbeiten . . . . *Schubert.*
Kunstschmiedeisen-Sammlung . . . *Hapelmann.*
Geschmiedete Gitter . . . . . *Adalbert Roeper.*
Deutsche Schmiede-Arbeiten . . . . *Adalbert Roeper.*
Der Kunstschlosser im Styl des XVI., XVII., XVIII. Jahrh. *Moser.*
Kunstschlosserei des XVI., XVII., XVIII. Jahrhunderts *Conradin Walther.*
Wiener Schmiedewerk des XVII., XVIII. Jahrh. . *Dr. Albert Ilg.*
Dresdner alte Schmiede-Arbeiten des Barock und Rococo *Richard Weisse.*
Wrought-Iron Work in Baroque and Rococo . *F. Ehemann.*
Modern Wrought-Iron Work . . . *Franz Brechenmacher.*

REVIEW OF THE ENGINEERING PRESS

The Flow of Water in Pipes.

THE problem of the flow of water is one of such importance that every contribution to the stock of original data is to be welcomed, especially if the observations are made with such a degree of scientific precision as will enable their value to be "weighed" in comparison with others, and used to check the results of existing formulas and methods.

A paper presented before the American Society of Civil Engineers giving the results of experiments on the flow of water in the six-foot steel and wood pipe line of the Pioneer Electric Power Company, at Ogden, Utah, is a most valuable contribution to the subject of the flow of water in large pipes, and the authors, Charles D. Marx, Charles B. Wing, and Leander M. Hoskins, are to be congratulated upon both the work itself and the manner of its presentation.

The importance of the tests will appear when it is understood that, so far as known to the authors, no experiments upon the discharge of new riveted pipes of diameter as great as 6 feet have been made, and the experiments upon riveted pipes of smaller sizes have been too few to furnish a basis for establishing a law for the relations of velocity, diameter, and other conditions.

Two sets of experiments were made, one upon a riveted steel pipe, of mean diameter of 72.22 inches and a length of 4,367 feet; the other upon a wooden stave pipe, 72.5 inches diameter and 2,710 feet long; the difference of level between the two ends of the steel pipe being about 360 feet, and of the wooden pipe about 50 feet, the profile giving varying slopes in various portions.

The main object of the experiments was to determine the relation between the rate of discharge of the pipe and the loss of head between certain definite points. To accomplish this it was necessary to measure simultaneously the pressure at each end of the length of pipe under experiment, and the rate of discharge.

The pressures were measured with mercury gauges, enabling a much higher degree of precision to be obtained than is possible with Bourdon gauges, while the discharges were determined by the use of Venturi meters, for which the necessary coefficients were furnished by the makers. As the rate of discharge was the measurement desired, and not the total volume, the automatic registers of the meters were not used, but instead there was attached to each meter a mercury gauge designed to show, at every instant, the difference between the pressures existing at the throat and the up-stream sections of the Venturi. This pressure difference indicates the rate of discharge instantly, and no time interval need be measured.

By taking observations simultaneously for a given length of time, and then causing the rate of flow to be changed and taking a fresh set of observations, repeatedly, a series of average results were obtained, which are tabulated and discussed at length in the original paper. For these details the reader must be referred to this original memoir, but some of the conclusions may be here recorded, especially in so far as they relate to the constants in certain well-known formulas.

Experiments at velocities ranging from 0.5 to 4 feet per second showed that it was unadvisable to use in the Chezy formula a value of "c" greater than 110, and, if the pipe is old, or there are frequent bends, the value should be still less. For the Kutter formula the usual value for "n" of 0.010, which is probably correct for pipes below 36 inches diameter, should be increased to 0.013 to 0.015 for the larger pipe; 0.013 being about right for the smooth wooden pipe. This appears to indicate that the Kutter formula is open to criticism for such large pipes, but additional evidence should be adduced before final judgment is passed in this respect.

Incandescent Lamp Efficiency.

THE term efficiency is used in connection with the performance of various devices without the real meaning of the term being always clearly understood, and this is especially the case with many electrical appliances.

A paper by Mr. Francis W. Willcox in the *Electrical World* discusses one phase of this subject in connection with the real meaning of incandescent lamp efficiency, and shows some of the elements which enter very largely into the efficient performance of incandescent lamps.

"Almost every one knows that the term efficiency is used to denote the power per unit of illumination consumed by the lamp at the beginning of its life, and that it is generally convenient to express it in watts per candle. For example, a 16-cp. lamp consuming a total of 50 watts is designated as having an efficiency of 3.1 watts per candle." This is the generally understood meaning of the term "efficiency," and forms the present basis of rating incandescent lamps. While this may answer for a sort of classification, it is not the true basis for determining the quality of the lamps, as it does not include the important element of the length of time at which a high efficiency is maintained.

After the early makers had overcome the difficulties of making lamps that will last, they endeavored to obtain the greatest amount of light with the least amount of power, while containing at the same time a fair average life. The result was the production of a lamp consuming at the start not exceeding 3.1 watts per candle, and, while such lamps gave a low average light during their life, they were hailed with great acclaim for the saving in power per lamp unit effected. In this way efficiency at starting, or initial efficiency, came to be accepted as a basis for determining the relative value of different lamps, the lamp having the highest efficiency (least watts per candle) with fair average life being judged the best lamp.

The present idea, however, is to give more attention to sustained candle power. "Were the efficiency of an incandescent lamp, like that of a motor or a dynamo, a constant quantity, practically unchanged by duration of service, the initial efficiency rating would, for a given voltage and candle power of the lamp, be a proper measure of its value. Such, however, is not the case, since as a result of the loss of candle power while in service, a lamp's efficiency changes considerably, the watts per candle augmenting, as a rule, in direct proportion to the loss in candle power. A proper measure of lamp value should consider not only the lamp performance at starting, but its after performance as well, for a given period of life. Average efficiency conforms to this requirement, and becomes, therefore, a proper measure of lamp value and test of lamp quality."

By illustrating the decline in candle power, plotting curves of candle power, taken at 75 to 100-hour intervals, it is clearly shown that the initial candle power falls off 40 to 50 per cent. during 600 hours of service. A comparison of four lamps, all showing the same initial efficiency, reveals a marked difference in average efficiency, while at the beginning the poorest lamp appears as good as the best.

It is therefore evident that initial efficiency is really only a classification for lamps, and not a measure of their value, and that its use for the latter purpose is incorrect and misleading. The real measure of lamp value is average efficiency, which includes not only the starting conditions, but the actual performance in a given period of life as well.

Wrought-Iron Compression Tests.

SOME important tests of the behavior of wrought-iron cylinders under compression have recently been made by Prof. W. Kendrick Hatt in the engineering laboratory of Purdue University, and from a report in *Engineering News* we give some of the principal results.

The main object of the experiments was to determine the influence of the shape of the specimen on its ultimate strength in compression, the ratio of length to diameter at which bending begins, the limit of plasticity, and the ratio of compression at that limit; and to obtain information

which might aid in the definition of a standard test piece for compression tests of ductile metals.

The tests were made upon cylinders of soft Swedish iron, using various ratios of length to diameter, in order to determine, if possible, the best ratio for a standard test piece, the results being plotted in curves, enabling the behavior to be readily seen. When the ratio of length to the radius of gyration exceeded 30, the specimen failed by bending, while at smaller ratios the bending was accompanied by bulging. When the ratio fell below 10, the failure was mainly due to bulging, accompanied by the formation of longitudinal cracks, and occurred at a stress equal to the limit of plasticity, this being between 64,000 and 76,000 pounds per square inch for the different specimens tested. The compression of the specimens followed the law of compression of elastic fluid.

By the limit of plasticity is meant that point at which the stress per square inch of actual area of cross section ceases to increase with increase of load. At this point the cohesion of the material seems to be overcome, corresponding to the point at which a tension test piece necks in.

From an examination of the curves and the tabulated records of the tests Prof. Hatt deduces that a specimen whose length exceeds ten diameters will give a satisfactory determination of the yield point. The "crushing strength," which we should fix at the same point as the limit of plasticity for ductile metals, may be determined from a specimen of a length of less than two diameters.

Steam Engine Trials.

IN some lines of work it is undoubtedly most desirable that the investigator should be unhampered by set rules or hard-and-fast methods, and where original research is the principal object this is a consideration which should not be overlooked. In the case of comparative tests, however, which are constantly being made of such standard devices as engines and boilers, it is almost necessary that there should be some degree of uniformity of method and record, if the results are to be of service to any one except the immediate observer; and even in his case much of the value of his work is lost, if the results cannot be readily compared with those of previous trials.

The importance of a standard method of conducting steam engine tests is clearly brought out by two papers presented at the recent convention of the American Society of Mechanical Engineers, at Niagara Falls, one by Mr. George H. Barrus, and the other by Mr. Bryan Donkin, and the result of the discussion which these papers elicited was the appointment of a committee to report at a future meeting of the society upon the subject.

Action of this sort has resulted in excellent work by committees of the society in kindred lines of work, and, as Mr. Barrus says, this has given the society a position in the engineering world which it would not have occupied had it followed a different policy. In the steam engineering line we now have a standard method of boiler testing, a standard method of conducting duty trials of pumping engines, and standard methods of testing locomotives; but we have thus far no standard which applies to the general subject of engine testing.

Mr. Donkin calls attention to the fact that the council of the Institution of Civil Engineers has taken the matter up and appointed a "Thermal Efficiencies Committee," which is shortly expected to issue its full report. A preliminary report of this committee was issued in the spring of 1897, giving some idea of the general view of the subject which might be expected to appear in the final report, and with this material in hand the American committee should have little difficulty in harmonizing its work with that of engineers in England. In this connection it is also interesting to note that the *Verein deutscher Ingenieure* is investigating the subject, and that its committee is in correspondence with the American society with a view of harmonizing methods.

Under these conditions it seems altogether probable that not only a standard method of conducting steam engine trials

will be devised by the American society, but also that the interest in the subject will result in the formulating of an international and uniform method of testing steam engines, which will enable the results obtained in America, England, or on the continent to be intelligently and promptly compared.

Both Mr. Donkin and Mr. Barrus suggest the desirability of classifying steam engines into groups or divisions, as it is manifestly impracticable to devise a standard method of testing which shall be adapted to all kinds of engines. It will be interesting to compare the two classifications, and it is probable that modifications in both will be found advisable in the end.

Mr. Donkin's suggestion is to group the subjects as:

Steam Boilers, Locomotive and Pumping Engines,

Marine and Factory Engines, etc.,

Rotary Engines,

Gas and Oil Motors.

Mr. Barrus divides the engines as follows:

Factory Engines, or engines employed in the production of power in general,

Pumping Engines,

Locomotives, (a) shop tests, (b) road tests,

Engines employed in generating electricity,

Marine Engines.

The suggestion of Mr. Donkin that gas and petroleum motors be included seemed to meet with favor with the society, as the committee was instructed to take that point into consideration in its deliberations.

Incidentally it is expected that the codes for testing steam boilers, locomotive engines, and pumping engines will be revised, and the whole subject unified and harmonized.

Mr. Barrus says: "The principal data required for an efficiency test of a steam engine are the weight of steam consumed, and the amount of power devoloped. These two elements of data are fundamental, whatever the type of engine and whatever the class of work performed. It is evident at the outset that a system of engine testing applicable to all engines would be a method of determining these quantities. Consequently the proposed standard would relate primarily to these two things and to the expression of efficiency derived therefrom."

The Thermal Efficiencies Committee puts the matter rather differently, and says, in its preliminary report: "For all purposes, except those of a scientific nature, it is desirable to state the economy of a steam engine in terms of the thermal units required per indicated horse power per hour (or per minute), and that, if possible, the thermal units required per brake horse power should be also given."

This obviates the consideration of the varying number of thermal units in the feed water, which must be included when the number of pounds of water per horse power is stated, and makes the method applicable to engines using superheated as well as saturated steam. Doubtless these two aspects of the subjects will be well considered, and the ultimate result will be a simple and uniform code, which will benefit both the engine builder and the customer.

Sampling Pig Iron for Analysis.

ONE of the most important points in connection with the determination of the chemical composition of any material used in the arts is the selection of a fairly representative sample for analysis. This is well understood in the assay of ores, and in the tests of fuels and minerals in general, and is equally important in the case of pig iron analyses.

This subject, so far as it relates to pig iron, is very comprehensively discussed in a paper by Mr. Albert Ladd Colby, published in a recent issue of the *Iron Age*, and some of the points made will bear repetition and emphasis.

To a certain extent the chemist may be held responsible for work put upon carelessly selected samples. "A little tact and extra energy on the part of the chemist in showing by chemical analyses the want of homogeneity in the various materials regularly analyzed, and hence the necessity of expending considerable time

and money to obtain representative samples of them, would effect a marked improvement, for no intelligent manager will continue a practice which is apt to yield misleading results, when by the expenditure of a little more money he can obtain figures which can be relied on."

One of the oldest and most frequently used methods is that of taking drillings selected from the beds, but, as usually conducted, it is open to much criticism. If an insufficient number of pigs are sampled, very variable results are obtained, the greatest variations occurring in silicon, sulphur, and carbon. A tabulated list of analyses is given in the paper to show that in some cases much higher silicon is generally found in the iron coming first from the furnace, and that in others the middle and later beds showed the higher silicon, while analyses by the writer showed the variations to be greater than consistent with trustworthy results. Variations in composition also occur in different parts of the same pig, so that the selection of test samples in this manner is not to be recommended.

"A much better, as well as cheaper, method of sampling is to cast four small test ingots while filling the beds, taking the first ladleful when the first bed is almost cast, and casting the last ingot when beginning to fill what will probably be, as near as can be judged, the last bed cast. An equal measured quantity of fine drillings from each ingot form, when thoroughly mixed, an average sample of the cast."

"This method of sampling has many advantages over the selection of pigs from the beds of the cast. It gives as good an average as can be obtained by the selection of pigs from different beds, and at the same time furnishes small, clean samples, free from sand and segregation, and more conveniently drilled than pieces of pig iron."

Another method, highly recommended, is that of selecting samples by dipping small ladlefuls from the runner, at least four times during the casting. These ladlefuls are run into a bucket of water, from a height of about 4 feet, the bucket being covered with coarse wire gauze to scatter the stream. The result is a quantity of uniformly small shot, and by having the bucket divided into four partitions the shot is divided and an equal amount of shot from each will form a sample of the cast. This shot is pulverized in a special form of steel mortar, until all of the sample selected will pass through a 100-mesh sieve.

This method avoids the irregularities due to segregation and to the presence of imprisoned sand, and the only disadvantage which it involves is that the phosphorus cannot be accurately determined in white iron by Drown's rapid method by oxidation with permanganate. This is not a serious objection, as but a short time is required to evaporate the solution to dryness and convert the phosphorus into ortho-phosphate.

In sampling for the determination of graphitic carbon either a representative sample must be selected by examination of the average fracture of the broken pigs, or, if the cast is subdivided and piled according to grade, a pig representing the grade of each lot must be selected and the carbons estimated separately in each sample.

In sampling cars of pig iron received by the buyer a customer cannot justly claim from the analysis of a single pig taken from each car of iron received that the furnaceman has failed to keep within the chemical analysis agreed upon; and the same rule holds good for the furnaceman in maintaining his position. If a contract requires the shipment of an iron of a certain average analysis, the customer's sample of each car should consist of carefully-mixed fine drillings from at least four pigs. Especial care should be taken to secure homegeneity of samples when they are distributed among several chemists for comparative tests; otherwise injustice may be done, and doubts cast upon conscientious and accurate work.

An appeal is made to the Foundrymen's Association to adopt representative methods of sampling pig iron, and there seems to be reason for the adoption of this course to the benefit of all concerned.

Air Compressors at High Altitudes.

THE well-known law of barometric decrease in atmospheric pressure with increasing altitudes must be taken into account in considering the performance of air compressors, and, as very many compressors used in connection with mining operations are situated at high altitudes, the subject becomes one of practical importance.

A general discussion of the question is given in the *American Machinist*, by Mr. F. A. Halsey, and the effect of altitude upon capacity very clearly shown.

"It is a very common impression that the amount of compressed air produced is in proportion to the barometric pressure, and that the consumption of power for a given amount of air at a given gauge pressure is the same at all altitudes. Neither of these impressions is correct. The amount of air delivered at different altitudes decreases slower than the barometric pressure, while the power required to produce a given amount of air increases with the altitude. In other words, while the power required to operate a compressor of given size decreases as the altitude increases, it does not decrease as fast as the volume of air delivered."

By a comparison of indicator cards and a simple computation Mr. Halsey shows that the output of a given machine does not diminish as rapidly as does the barometric pressure, the assumption being that the air is delivered at the same pressure in both instances, but taken in in each case at the pressure corresponding to the elevation of the compressor.

A point which must not be overlooked is that the effort necessary to open valves and fill the cylinders is practically the same at all altitudes, and hence the relative importance of this resistance becomes greater as the altitude increases.

"The increased number of compressions necessary to produce a given gauge pressure at an elevation lends an added value to compound compressors in such locations. The clearance loss increases with the ratio of compression, and hence, for a given gauge pressure, is greater at high altitudes than at low. For example, six compressions at the sea level with an initial cylinder pressure of 14 pounds will give a final gauge pressure of 69.25 pounds, while at 10,000 feet altitude the same number of compressions would give but 45.85 pounds gauge pressure, and so far as clearance losses are concerned there is just as much reason for compounding for 45.85 pounds at 10,000 feet as there is for 69 25 pounds at the sea level.

"Considering the reduced delivery of compressors at high altitudes, the increased cost of a machine for a given duty, and the increased power cost of a given amount of air, it is clear that a given percentage of loss is a more serious matter in such machines than in those located at the level of the sea, and that compounding is justifiable when its percentage of saving is less in the former case than in the latter. There can be no doubt that at the altitude at which many mining plants are located compound compressors should be used in all cases."

Mr. Halsey gives a very convenient table showing the relations between power, output, and pressure for various altitudes, thus enabling computations to be avoided in practical work, and permitting the results to be determined with a degree of precision quite within the limits of working requirements.

Testing Iron and Steel.

THE increasing attention which is being given to the investigation of the properties of materials of construction renders the valuable paper of Mr. Paul Kreuzpointner upon the subject of testing iron and steel, published in the *Journal of the Franklin Institute*, especially interesting at the present time.

As Mr. Kreuzpointner well says: "If we know much about the behaviour of iron and steel under strain, our methods of testing will be the proper ones, and we will thereby obtain, or buy, with that large amount of knowledge, a maximum of security, of safety, of reputation, of freedom from danger, anxiety, and worry, of financial and social success for the investor and engineer. On the contrary, if our knowledge in this line of pursuit is in-

ferior and defective, our methods of testing will be inferior and defective, and we can buy but a minimum of safety and success, with consequent loss through avoidable repairs, renewals, the use of more metal than necessary, or inferior metal, with all this implies."

In discussing the various methods, Mr. Kreuzpointner intimates that the value of the tensile test has been overrated to a considerable extent, although it is nevertheless a most valuable and indispensable guide. In many cases a bending or nicking test will show the internal make-up better than a tensile test of the same material, but at the same time the judgment of the individual and a knowledge of the methods of manufacture enter into the nicking test to a much greater extent than in the tensile test.

In a tensile test, the elastic limit, as indicated by the drop of the beam of the testing machine, is a point to which often much importance is attached. Engineers and their inspectors use this drop of the beam in commercial testing almost exclusively, and of course the mills do not object as long as the consumer is satisfied. To this method of taking the elastic limit, however, Mr. Kreuzpointner gives scant consideration, and, after discussing what really may be supposed to take place in molecular rearrangement when the elastic limit is reached, he shows that, even if the beam drops temporarily, the metal is weakened momentarily to such an extent that it cannot carry the load, there has been an entire and radical change of structure, and the engineer begins to deal with new and unknown qualities of the metal. The method of taking the elastic limit with the dividers, crude as it is, is more reliable for revealing the true condition of the metal under test than the drop of the beam, which not only gives too high a value, but also gives results contrary to accepted theories and practical experience. Still more reliable are some special instruments now in the market, which although they may not be perfect, are a great improvement over the data obtained by the drop of the beam.

Mr. Kreuzpointner also discusses in a very clear manner the relative value of the drop test, and shows its true importance as a measure of shock-resisting power.

The quenching test as a measure of quality and practical utility may be considered of doubtful value. So many variables enter into the successful performance of this test that it is very easy to produce such conditions as will nullify the object which we intend to accomplish, and, as usually performed, it is a mere piece of guesswork, unjust to the manufacturer and misleading to the engineer.

There is much in this valuable paper which cannot be abstracted here, and the high standing and wide experience of the author should render all who have to do with the testing or using of iron and steel interested in the perusal of the entire paper.

The Cleveland Water Works.

THE location of many important cities on the shores of the great lakes, and the necessity of drawing the water-supply in such cases from the same body of water into which the sewage is dischaged, has required the contruction of intake tunnels, running out far enough to be beyond all danger of contaminating the drinking water by the sewage.

The most recent important construction of this kind is the new intake of the water works of the city of Cleveland, Ohio, of which a full account is given in the *Engineering Record*, from which the following points are abstracted.

The location of the new intake is situated about 3½ miles from the shore, and about 5 miles from the pumping station, at a point where the prevailing currents will prevent the possibility of the approach of sewage, and from this point is conducted a 9-foot brick-lined circular tunnel with walls 13 inches thick. The tunnel is nearly parallel to the bottom of the lake, at an average depth of 50 to 60 feet below it, vertical shafts at the extremities providing for the intake of the water at the lake end, and the delivery to the pumping engines at the land end.

The construction of the tunnel is now being conducted from three cribs in the

lake, as well as from the shore end, two temporary cribs and shafts having been made, thus giving six headings for tunneling. The strata through which the tunnel runs consist of hard clay with pockets of quicksand and gravel, and thin horizontal seams of quicksand, and during the work but little trouble has been encountered from water, as the air pressure of about 23 pounds to the square inch has been ample to keep back water that might otherwise have entered through the seams of sand.

The details of the air lock, and the constructive features of the cribs and shaft sinking works, form the most interesting position of the work, and these are fully illustrated and described in the article referred to. A curious point in this connection is the fact that the mules are apparently much more seriously affected by the compressed air than are the men, a number of the mules having died suddenly, apparently from the effects of the air pressure.

The fourth shaft, which is to be for the permanent intake and lake connection of the tunnel, will be surrounded by and built through a permanent steel crib, which is partly completed, but not yet sunk in position. It consists of a cylindrical steel structure 100 feet in diameter and 70 1-2 feet high, with a concentric inside cylinder 50 feet in diameter, both made of steel plates 3-8 of an inch thick, thoroughly riveted and connected by 24 radial vertical plate diaphragms,which divide the annular space into 24 water-tight compartments. The inner well supports a square steel dwelling and lighthouse structure 31 feet in height, which affords storage and a residence for the light-house keeper. The inside well will communicate with the open lake by means of 12 radial inlet tunnels through the annular space, with orifices in both cylindrical surfaces to admit water at levels of 14 and 26 feet below the surface.

The completion of this work, which is now being actively pushed, will give the city of Cleveland a supply of water from Lake Erie from a point so remote from any source of contamination as to be very satisfactory so far as health is concerned, while the size of the tunnel renders the amount of supply practically limited only by the pumping capacity.

THE BRITISH PRESS

The Cost of Electrical Energy.

ONE of the most valuable papers for the year is undoubtedly the masterly essay of Mr. Robert Hammond, before the Institution of Electrical Engineers, upon the cost of generation and distribution of electrical energy, and the widespread attention which the paper has attracted shows very clearly the appreciation of the subject by the engineering and commercial fraternity.

The production and sale of electricity is capable of investigation to a much greater extent than is almost any other industry, since the electric lighting act of 1882 required the filing of detailed yearly statements containing much more information than could otherwise be obtained. This requirement has worked to reduce operating costs and to secure to the consumer a fair proportion of the saving thus effected.

Mr. Hammond has taken these statements from 1890 down to 1896 and 1897 and summarised them in full tabular form, and has then so discussed them as to analyse the various factors of cost and enable definite conclusions to be drawn—at least, so far as the United Kingdom is concerned. In all the tables the figures are given in board of trade units,—*i. e.*, kilowatt-hours, —the cost per unit being given in pence, distributed into costs for coal, oil waste and stores, wages, repairs, and maintenance, these forming the works-cost, and to these being added rent, rates and taxes, and management expenses, to obtain the total cost. With these is also given the approximate price of coal, thus enabling the influence of fuel cost to be indicated in making comparisons of other factors.

As might be expected, these reports show a great diversity of results, and it is the ascertainment of the causes of these differences that is the main object of Mr. Hammond's analysis. Taking the returns for 1894, 1895, and 1896 as expressing most nearly the existing conditions, and arranging them in order of merit, the total cost per unit ranges from 1.13d. to 6.04d., if we omit special items such as Crystal Palace, 8.73d., and Salford, 12.57d., which are so far above the others as to be out of the question for purposes of comparison. A review of nine of the leading works shows that a total cost of less than 2d. per unit has been successfully maintained during 1896–1897.

In examining the conditions which make these low costs possible a number of points are to be noted.

In the first place, the data under review show conclusively that output is the greatest factor in the reduction of costs per unit. This is clearly shown by graphical diagrams giving the relation between the number of units sold and the cost per unit, the cost falling rapidly as the output increases from year to year.

The next item bearing upon reduction in cost is the load-factor, or the ratio of the actual units generated to the product of the maximum of the year and the total hours of the year. The advantages arising from a high load-factor are so universally acknowledged that Mr. Hammond produces his data only to sustain the truth of the assumption.

A third element in low costs is the reliability of plant, a perfectly reliable generating and distributing plant having an important bearing on costs. Apart from the obvious necessity of procuring a high-class equipment in the first place, the importance of thorough testing upon installation is insisted upon; no plant should be accepted until it has met a rigid test in every detail.

Closely allied to this is what Mr. Hammond calls the "engineer factor." In every one of the works in which low costs prevail the engineer in charge is distinguished for ability, assiduity, earnestness, and rigid weekly analysis of his works costs. The engineer factor certainly operates in a most important degree toward low costs.

The efficiency of the generating plant

and that of the distributing plant naturally are important factors in the cost question, while the so-called all-round efficiency is an item in which the two are combined. These are discussed by means of curves and tables, and a general summary shows the relative importance of the various items.

While many of the factors are rather administrative than of an engineering nature, the two are so closely interwoven that it is instructive to see them handled by an engineer in so forceful a manner, and, although many of the points made by Mr. Hammond are of a local character, in the main his conclusions apply in all countries where electricity is used to any great extent.

In conclusion, Mr. Hammond ventures into the dangerous region of prophecy, based, however, upon past experience of a definite nature, and predicts that when, in the city of Leeds, the output reaches 5,000,000 units, the total costs will be reduced to 0.75d. per unit.

Crank Arrangement in Quadruple Engines.

THERE has been some difference of opinion as to the most advantageous arrangement of cranks in quadruple-expansion engines where the four cylinders have independent crank connection, and the results of a number of experiments form the matter of a paper by Mr. A. L. Mellanby, read before the North East Coast Institution of Engineers and Shipbuilders, at Newcastle-upon-Tyne.

The main object of the trials was to find out which was the better of the following arrangements,—the cranks H. P., 1st I. P., 2nd I. P., and L. P., in the order given, or the cranks H. P. and 1st I. P. opposite each other and at right angles to the 2nd I. P. and L. P.

The tests appear to have been made with much care, and the definite character of the results speaks well for the accuracy of the work. The engines were of the vertical marine type, with four cylinders and four cranks, the sizes of the cylinders being as follows: high pressure, 7 inches; 1st intermediate pressure, 10½ inches; 2nd intermediate pressure, 15½ inches; low pressure, 23 inches; common stroke, 18 inches. The crank shaft was arranged with couplings which permitted the order of the cranks to be readily changed while all other conditions remained unchanged; hence any variation in efficiency could be attributed to the true cause.

By the use of the Froude hydraulic dynamometer the entire power of the engine could be absorbed and measured, while measuring-tanks enabled the amount of feed-water to be measured; the detailed results of the tests therefore contain information of general value as to the performance of this type of engine, apart from the facts as to the especial point under investigation. Tests at various pressures were made, with the principal object of checking the general results, for, as Mr. Mellanby remarks, the only really important ones are those made at 210 pounds, pressure, as it is not advisable to work a quadruple-expansion engine in actual practice at a pressure much below this.

The results of the two series of trials are given in the paper, both in tabulated form and as plotted curves, showing very clearly a marked advantage in the arrangement called "cranks opposite,"—*i. e.*, with the H. P. and 1st I. P. opposite each other and at right angles to the 2nd I. P. and L. P.

Taking the tests at 210 pounds' pressure, the water-consumption per horse power (brake) per hour for the cranks opposite is given as 14.03 pounds, or 12.53 pounds per indicated horse power; while for cranks at right angles the corresponding figures are 14.39 and 12.77 pounds respectively. These are good figures for an engine indicating only about 150 h. p. under any circumstances, especially as this is an actual measured water rate, and not one computed from the indicator diagrams. The brake horse power averaged about 90 per cent. of the indicator power, and the general consistency of the results adds value to the figures as reference data.

Mr. Mellanby makes some excellent remarks upon the general subject of engine tests, and calls attention to the necessity of examining the results from isolated trials very carefully, as, from the nature of the case, errors are liable to creep in, which,

with only one determination, may be lost sight of. This, without doubt, has much to do with the conflicting results of engine trials, and it is to be regretted that so many sweeping assertions have been made from the results of one or two trials. When a number of tests are made, each can be used to check the others, or, when the results are plotted in the form of a curve, any wide deviation from the evident general trend can be re-examined and errors can be eliminated.

In connection with the effect upon efficiency due to arrangement of cranks, the question of steadiness of turning moment must also be considered. There is a notion prevalent that the turning moment for a four-crank engine must be very uneven, especially for the arrangement called "cranks opposite," which some engineers consider almost as bad as that for a two-crank engine. The actual curve shows that this is not so, the turning moment being very steady throughout a revolution. There is practically no difference between the minimum and the maximum values for the two cases, although the "cranks opposite" seems, on the whole, to have the steadier turning moment.

Balancing Steam Engines.

In a careful review of a paper on balancing steam engines, read before the Manchester Association of Engineers by Mr. James Whitcher, the *Engineer* brings out some points of value which are not always sufficiently considered.

The fundamental principle which must not be overlooked in the practical operation of balancing is that a rotating mass cannot be made to balance a reciprocating mass, but that only rotating masses can be made to balance each other. In the cases of high-speed engines, with several cranks, the problem of balancing becomes one in which the correct theoretical principles must be fully understood and correctly applied, if a fair measure of success is to be attained.

Let us leave for a moment all reference to the reciprocating parts of a steam engine, and confine ourselves to the rotating elements only. Every rotating mass or group of masses tend to revolve around its common centre of gravity, and, if it is permitted to do this, peace will prevail, and there will be no vibration.

To use Rankine's words: "The condition which it is desirable to fulfil in all rapidly rotating pieces of machines is that the axis of rotation shall be a permanent axis. The question whether the axis of a rotating piece is a permanent axis or not is tested experimentally by making the piece spin rapidly, with its shaft resting on bearings which are suspended by chains or cords so as to be at liberty to swing. If the axis is not a permanent axis, it oscillates; if it is, it remains steady; when the axis of rotation traverses the centre of gravity of the piece, there is said to be a standing balance; when it is also a permanent axis, there is a running balance."

It is this difference between a running and a standing balance which makes it impossible for cranks even a few feet apart to balance each other, even though identical in weight and dimensions and placed at an angle of 180°. Each crank must be balanced by its own counterweights, placed as nearly as possible in the same plane of rotation, so that the centre of gravity of the crank and of the balance weights can be made to coincide with the centre of the shaft, and also with the middle point in space between the two crank cheeks.

Taking up now reciprocating masses, it must be considered that only reciprocating masses can balance each other. The reciprocating masses must move in opposite directions; if not in the same plane, then in not fewer than three planes. As an example of the counter-balancing of reciprocating masses in three planes may be cited a three-cylinder vertical compound engine, with cylinders all of the same size, the central one being high-pressure, the other two low-pressure, and the weights of the moving parts of the two low-pressure portions just equalling those of the high-pressure part. The cranks being counterweighted separately, and placed 180° apart, such an engine should run without vibration, reciprocation and rotation taking place in three planes, which fall between the crank shaft bearings.

In the case of triple-expansion engines, with three cranks at 120°, the parts cannot be made to balance each other, and so "bob" weights must be added. It is suggested, however, that the combination above described, with the addition of a tandem cylinder on top of the middle section, would enable a triple-expansion engine to be constructed capable of perfect balance by the proper distribution of the weights of its own moving parts, without the need of any "bob" weights.

The whole subject is one which, while requiring care and study, demands rather the exercise of judgment and common sense than the application of an elaborate mathematical analysis.

The Electric Driving of Machine Tools.

IN the development of electricity as a means of power-transmission one of the most important applications is only beginning to be appreciated,—namely, the distribution of power to the various tools in the machine shop.

A recent article in the *Electrician* calls attention to the progress which this branch of applied electricity is making in various countries, and discusses some of the conditions of its development.

One of the earliest machine-shop appliances in this class was the electric crane, and there is little doubt to-day that electricity is, *par excellence*, the motive power for just such service as is demanded for hoisting and handling materials. It is, indeed, interesting and curious to note that, in England at least, the class of works in which electric driving has received its earliest adoption has been one demanding large amounts of power and involving heavy strains upon the driving machinery. Nowhere has electric driving been so extensively and successfully practised as in the shipbuilding yards and engine works of the north-east coast. Yet experience has amply demonstrated the suitability of electric driving for every-day work of this most severe description; indeed, the test of electric trolley lines had already shown the applicability of electricity to intermittent and irregular work, and few machine shops offer the trying conditions that are daily met on every electric tramway.

At the same time it is the flexibility of its character which renders electric driving of so general adaptability, for, in workshops where the work is lighter and of a more delicate character, the electric motor has shown its fitness, an excellent example of this being a bicycle factory.

As to the system to be preferred for shop driving, it is yet too soon to predict. Direct currents have been employed with success, while on the continent and in America the two-phase and three-phase systems have been extensively used. Separate motors are to be preferred in most instances, especially when the utmost steadiness is desired, dispensing with intermediate belting or other forms of gearing; but in many shops the group system of isolated countershafts, each with its own motor, and each furnishing power to its own group of near-by tools, has been found advantageous.

When we consider the losses by the use of shafting, belting, and gearing in the ordinary methods of power transmission in machine shops, the greatest economy in the use of electricity is found to result from the elimination of the frictional losses, which, under existing methods, often amount to more than one-half of the total power generated; and there seems to be every reason to expect that ultimately nearly all the distribution of power for manufacturing purposes will be made by the electric current.

Feed Water.

THERE are a number of so-called minor details in steam engineering which, in the total, amount to an important item, so far as the economic performance of a plant is concerned. Among these must be included the purity of the feed water from which the boilers make their steam. An excellent editorial in the *Engineer* discusses this subject from a common-sense point of view, and shows how much may be gained by giving proper attention to the character and suitability of the feed water used under any given circumstances.

Much of the neglect with which this matter has been treated is due to the fact that almost any water, however bad, can be used for a time to make steam; and the lower the pressure, the longer the period during which a boiler may be worked without being ruined with even very bad water.

With modern high pressures, however, every defect in feed water is aggravated as the pressure rises. The salts of lime and magnesia are thrown down with increasing rapidity, and in larger quantity as the pressure and temperature increase; so that the deposit becomes denser and more adherent at the very time when the metal is rendered less able to withstand it. Indeed, engineers generally appear to be waking up to the fact that something will have to be done in the way of improving feed water, if the increase in steam pressures is to be continued.

It is well known that absolutely pure water is not good for boilers. Indeed, boilers which have been badly scaled have had the scale quickly dissolved and removed by the use of a very pure feed water, and, if there is no scale to dissolve, the boiler itself will soon show evidence of pitting and corrosion. On the other hand, too much lime, either in the form of carbonate or sulphate, will soon produce "furring" and thick scale, with the inevitable accompaniments of diminished efficiency and possible burned tubes or collapsed furnaces. "Long practice has proved that the best possible results are obtained where all the interior of a boiler becomes covered with a very thin continuous scale of lime. No doubt there is a small loss incurred by the presence of the non-conductor. On the other hand, the durability of the boiler is enormously increased. Indeed, when such a scale can be maintained, the boiler is subject to no wear whatever from the inside, and would last for an indefinite time, were it not for the effect of the hot gases on the tubes and plates outside. This scale can always be attained afloat by filling the boiler with sea-water, and disregarding the rise in density which invariably, from some hitherto-unexplained cause, takes place when the same water is used over and over again. When in port, the whole of the water in the boiler may be blown out and the boiler filled up again from the sea; but all loss when on a voyage should be made up with fresh water from an evaporator. On land there is no difficulty in getting the scale; the trouble lies in preventing it from becoming too thick."

Without attempting to suggest any especial panacea for bad feed-water, it is at least worth while to call attention to the increased necessity of providing better water, in view of the higher pressures now in general use. The correspondingly-increased temperatures cause a precipitation of sulphate of lime, which forms hard scale, and the liability to burning is altogether too great to be overlooked.

"The difference in the cost of boiler maintenance depends to an extent that is not generally realised on the quality of the water; and it is not too much to say that in every well-appointed works or factory appliances for softening, purifying, and heating feed water are as essential as the boilers themselves. Regarded as an investment, there is no other from which the steam-user will get a better return for his capital."

The Iron Resources of India.

THE large importations of iron ore from Spain form an important item in the supply of material for one of the chief steel-making processes of the United Kingdom, and the visit of the members of the Iron and Steel Institute to Bilbao in 1896 gave the members an excellent opportunity of judging the extent to which Spain has been the gainer from this source.

An editorial in a recent issue of *Engineering* calls attention, however, to the possibility of keeping this business to a large extent in the British empire, since there are ore deposits in India which might partially, if not altogether, replace those from which the Spanish supplies are drawn. The matter is all the more worthy of consideration, since it is understood that the Spaniards are casting about to see how they can become steel makers in place of simple ore producers—cutting at

the British steel trade, which brought the Spanish ore industry into being, and making it all the more desirable that a substitute imperial product should be used.

The *Times* has pointed out that iron ore abounds at Chanda, in the central provinces; the Iron Mountain containing crystalline hematite of extreme purity, while at other places are deposits of a most tempting nature, the ores being described as almost entirely free from phosphorus.

The cheapness of labour and the comparative proximity to the sea should also render these ores successful in competition with the American product, the deposits being less than four hundred miles from Bombay.

Another possible source of ore is found in the Salem district, in the province of Madras, upon which an exhaustive report has been made by Mr. Jeremiah Head. The argest and most accessible deposit is that known as the Kanjamalai. "It is six miles from Salem, and close to the railway which connects the city with Madras on the east coast, the distance being 200 miles, whilst Calicut, on the west coast, is 180 miles distant. Kanjamalai is a hill, having three principal beds of magnetite, each on the average 50 feet thick, 4½ miles long, and 1½ miles broad. According to a section given, the deposits extend from side to side of the hill, dipping boldly in the centre and cropping out fully at the surface. The possible yield of the three beds is estimated at 900,000,000 tons, supposing there is no interference, being equal to the total exports from Bilbao for 225 years."

The matter of the possibility of profitable export of these and other Indian ores is one to question, but it may be worth while to investigate the practicability of smelting the ores in India. Mr. Head is of opinion that this depends largely upon the question of the supply of charcoal fuel, but is also complicated with local financial and transportation matters. He is unable at present to see how iron can be manufactured in India from native ores cheaply enough to make it a competitor of imported pig, but the introduction of extensive modern methods may overcome these difficulties, and enable India's riches in iron to be so developed as to divert the large sums now paid to Spain to a point in the British empire at present undeveloped in this respect.

Railway Progress.

THE inaugural address of Mr. Samuel Waite Johnson, the new president of the Institution of Mechanical Engineers, dealt with a subject upon which he was especially fitted to speak, and one which, as he remarked, had not formed the theme of any of his predecessors.

The history of the growth of railways is equally the history of the growth of mechanical engineering; for, even in its latest development,—the electrical production of power and light,—we have not only railway stations, passenger coaches, and goods yards profusely lighted by electricity, but also both overhead and underground railways worked successfully by the same agency, and paying dividends to shareholders.

The close relation between the development of railway enterprise and the general prosperity of the country renders the growth of British railways an excellent index of the prosperity which has prevailed during the Victorian era, and it is interesting to observe that the plotted returns of the board of trade form an excellent record of the fluctuations in general trade conditions.

Without attempting to account either for the fact or for the time interval, Mr. Johnson called attention to the recurrence of periods of prosperity at intervals of eight or nine years. The first prosperous period shown by the passenger returns began about 1862, and the succeeding ones in 1870, 1879, and 1888. On the whole, since 1862 the increase has been wonderfully regular, the periods being generally most clearly marked when the figures for the United Kingdom are taken, and least regular when only a single railway is considered. Similar periods are shown for the goods and mineral traffic, but the periods of depression are much more marked than for passenger traffic, and reach their greatest intensity a year or two earlier. Marked irregularities are

also introduced by strikes, and by other trade disputes.

These and other relations which have developed during the sixty years of railway progress in Great Britain were clearly exhibited by Mr. Johnson, with the aid of diagrams and tables.

In 1855 the longest run was 24 miles and the speed 42.3 miles per hour. In 1897 the longest run was 124 miles and the speed 52 miles per hour,—a very considerable increase in view of the increase in the weight of trains.

The advances in locomotive construction and design have, of course, been most marked, and the present practice of the Midland road is especially interesting. Piston valves have not come into general use for locomotive engines, although in a well-known type of American compound engine they are employed; but Mr. Johnson has adopted the piston valve for his single-driver express locomotives. Compound engines have not yet found acceptance on his road, largely because of the excellent economical performance of the simple engines.

A marked gain in fuel economy has been attained in recent years, and during the eight years terminating in 1880 the consumption showed a decrease of 9.68 pounds per train-mile, or 17.22 per cent. of the amount of fuel formerly burned, this large reduction being effected by revising engine and boiler details and by building locomotives of greater power and therefore better capable of dealing with trains.

The improvement in permanent way has necessarily kept pace with the development in rolling stock, and the substitution of steel for iron, both in rails and in bridges, is an advance without which the present rate of traffic could not safely be maintained. The old wrought-iron fish-belly rail, weighing only 35 pounds per yard and only 15 feet long, has been replaced by the modern steel rail, which weighs 100 pounds per yard and is 36 feet in length.

Mr. Johnson expresses freely his preference for a gauge of 5 feet 3 inches, mainly on account of the crowding of the machinery between the frames which is necessary with narrower gauges; but this is evidently the consequence of the use of inside cylinders. For outside connected locomotives the standard gauge of 4 feet 8½ inches is found wide enough.

Many interesting and valuable points in the address are necessarily omitted in this brief glance, as well as the numerous illustrations, which added much to the force of the historical portions.

In closing, Mr. Johnson emphasised the value of such a retrospect in giving confidence for the future, because the conditions affecting both railway and marine engineering, which have so greatly promoted progress in the past, are still dominant, and these two branches of locomotion have brought all parts of the world within comparatively easy reach of one another, thus enabling the "old country" to profit by the growth of the more distant portions of the empire, as well as by the prosperity of neighbouring nations.

The Staines Reservoirs Scheme.

THE extensive plans for the increase of the water-supply of London, the execution of which is already in progress, will doubtless furnish much valuable experience in the department of water-works engineering. We refer at present only to the general outline described in recent issues of the *Journal of Gas-Lighting and Water-Supply*.

The scheme includes the construction of a number of storage reservoirs in the neighbourhood of Staines, taking the supply from the Thames, the Wraysbury river, and the Colne brook, the water to be delivered to the three London water companies for distribution. The maximum quantity of water to be taken from the Thames is limited to 100,000,000 gallons, and no more than 35,000,000 gallons is to be delivered to the three companies on any one day, except in case of emergency, in which case the amount may be increased to 45,000,000.

The water is to be taken from the Thames on the Middlesex bank, a short distance above Bell Weir, by a powerful installation of pumping machinery, and

delivered to the reservoirs through two riveted steel mains, each 6 feet 3 inches in diameter, joining into a steel pipe 8 feet 8 inches in diameter, from which branch pipes will be run to the reservoirs.

The impermeable character of the London clay, upon which the reservoirs will be founded, makes the construction a matter of contract work rather than of great engineering skill, but the great size makes the undertaking a notable one. The embankments will vary from 21 to 35 feet in height, and will be formed of material excavated from the interior of the reservoirs. The slopes of the embankment are three to one inside, and two to one outside, the reservoirs. In the centre of each bank a puddle wall will be constructed 6 feet thick at the top, 7 feet at the ground level, and tapering down to 5 feet where it joins the London clay, into which it will be securely toothed, this construction being relied upon to make the reservoirs perfectly tight. The insides of the slopes are to be lined with concrete, so as to resist the wave action expected to take place on a body of water so large as this will be. Reservoirs No. 1 and No. 1A will be about 1¼ miles long by ⅛ of a mile wide at the northern end, and nearly a mile wide at the southern end.

The content of the reservoirs originally authorized was 2,500,000,000 gallons, which it is proposed to increase to 3,300,000,000 gallons.

This increase has been undertaken by the Joint Committee, because, having already purchased a portion of the land, the extension, which will be an additional safeguard to the Thames in times of drought and will be in the interest of the consumers, can be made at moderate cost. The aqueduct and reservoirs will be guarded on all sides by an unclimbable wrought-iron fencing; and the embankments will be sown with grass.

The conduit will be carried under the London and Southwestern Railway and follow the line of the Staines and Kingston Road to Sunbury Cross from which it will be diverted to a reservoir of about 30,000,000 gals. capacity to be constructed to the east of Kempton Park. The New River Company will take its water from the aqueduct between the East London Water Works and the Thames Valley Line, while the Middlesex and Grand Junction Companies will receive their proportion of water from the Kempton Park reservoir; proper measuring apparatus being provided at the Thames inlet and at the companies outlets.

THE CONTINENTAL PRESS

Blast-Furnace Power Gas.

THE interest in the practical application of the waste gases from blast furnaces for the generation of power in gas engines has already been discussed here more than once, but the subject appears to attract continual attention in the technical press on both sides of the Atlantic.

Following the discussion on Herr Lürmann's paper, read before the Verein deutscher Eisenhuttenleute at their recent convention, and noticed in these columns last month, we have an editorial discussion in *Stahl und Eisen*, with special reference to the tests made by Professor Hubert upon a blast-furnace power gas plant at Cockerill's works, at Seraing, Belgium.

These tests are of especial interest in this connection, because they include a careful investigation of the character and calorific power of the gases and an examination of the value of the methods of using them prior to the application of the gas engine; and it is not too much to say that the results of Professor Hubert's work fully answer the objections made by Herr Lürmann as to the feasibility of the introduction of the method.

A number of tests of the gases, both by analysis and calorimeter, showed an average of 997 calories per cubic meter, and about 40 per cent. was used in the hot blast stoves and the remaining 60 per cent. burned under steam boilers; but, in order to be on the safe side, Professor Hubert takes only fifty per cent. of the gas output as available for power generation, leaving the other half to be used for heating purposes.

The engine in which the gas was tested was of the style known as the "Simplex" gas engine, with slight modifications adapting it to the character of the gas, the principal changes being the use of a higher degree of compression than is required for illuminating gas, and the addition of an accumulator in connection with the electrical ignition. The addition of a simple washing apparatus was found sufficient to remove the dust and mechanical impurities from the gas to an extent which made it clean enough to prevent injury to the cylinder of the engine, as is shown by the fact that the gas engine at Seraing ran continuously for a year with furnace gas without any serious injury.

Without going into the details of the tests, it may be of interest to give in full the conclusions at which Professor Hubert arrived, bearing in mind the fact that these are deductions from theoretical investigation and practical experience.

A. In the production of one ton of pig iron there are also produced about 5 750 kilograms of gas, or about 4,300 cubic meters, at 150 C. A 100-ton blast furnace will produce therefore about 18,000 cubic meters of gas per hour.

B. Under the assumption that fifty per cent. of this gas is used in the hot-blast stoves, there remain 9,000 cubic meters available for power, which, with an efficiency of twenty per cent. for the gas engine, at 1,000 calories for the thermal value of the gas, corresponds to 3,000 h. p. as the value of the gas from a 100-ton furnace, or from three to ten times the power hitherto produced by burning the gas under steam boilers.

C. From the tests upon the engine at Seraing, which has been in successful operation for more than a year, the consumption of gas is between four and five cubic meters of gas per h. p. per hour.

Taking the maximum consumption of five cubic meters, we have a practical result of 1,800 h. p., of which only 400 is required for the purposes of the furnace, leaving 1,400 available for other purposes.

D. With the progress which has been made in the design and construction of large gas engines, there is every prospect that we may soon have blowing engines operated by gas motive power cylinders, thus enabling the entire power to be obtained by the utilisation of the furnace gases.

E. The use of the gases as a direct source of power will greatly reduce the first cost of the plant by dispensing with the expense involved in the steam boiler plant, the gas engines themselves replacing the steam engines.

F. The cost of the water for the cooling and washing of the gas and for the cylinder jackets of the gas engines is not greater than that for condensing purposes in the case of condensing steam engines, so that no extra charge is to be made for the gas engines on that account.

G. When, as is now frequently the case, the blast furnaces form part of a general iron and steel works, in which large quantities of power are required for rolling mills, forges, machine shops, etc., the power produced by the gases in excess of the furnace requirements is directly available for the other mechanical operations, thus enabling such plants to compete, so far as power cost is concerned, with the great hydraulic power installations which depend upon natural sources of energy.

The matter seems to be passing well out of the hands of the investigators into those of the constructing engineers. It is now the turn of the engine builders to produce large gas engines, especially adapted for use with lean gas, and suited for continuous heavy duty, and the part of energetic ironmasters to take active steps to introduce the new system. Already, it is reported, a blowing engine to be operated by gas power is being designed for the Cockerill company, and others should not be slow to follow.

Automobile Vehicles.

ALTHOUGH the subject of motor carriages and other automobiles has received earnest and practical attention both in England and in the United States, it is on the continent that the most activity has been shown, in the construction of both light and heavy vehicles.

A very full and lavishly-illustrated review of the present state of automobile construction has been contributed to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* by Professor Czischek, himself well known as a pioneer in this field, and a designer of an effective form of steam tricycle.

In discussing the subject, Professor Czischek first considers the resistance to be overcome on roads of various kinds for vehicles of different weights, using as data the results of the experiments of Michelin in Paris, to which he adds the not unimportant factor of wind resistance, and shows how the actual horse power required for any given conditions of operation may be computed. The formulas for this purpose are checked by the results of the "poids-lourdes" competition in France, and also compared with the *Times-Herald* trials at Chicago, the results being tabulated in a form which renders them available for reference for future design.

In considering the sources of motive power available for automobile purposes, steam is first discussed; then the various kinds of internal combustion motors, using petroleum, benzine, acetylene, and similar materials, these having been more extensively employed on the continent, perhaps, than any other forms. The use of electric accumulator batteries is also referred to as undoubtedly the most elegant solution of the motive power problem, and some examples of storage-battery vehicles are given; but so far electric power has been given more successful application in England and America than elsewhere.

As Professor Czischek rightly observes, the most difficult point in automobile design lies in the transmission of the motive power to the point of application, the mechanism for this purpose necessarily differing materially for different kinds of motors. The benzine motor, for example, runs at a constant speed of about 700 revolutions per minute, and requires a reduction to a speed varying between 25 and 100 revolutions on the driving wheels. Electric motors are more readily controlled, but also require much reduction. Probably steam is more easily handled, as regards actual speed and changes in velocity, than any other motive power, but the objections to it in other directions are obvious.

Many of the constructive details of motor vehicles have been adapted from bicycle

construction, the wheels, ball-bearings, pneumatic tires, etc., having been used almost without change, except as regards dimensions. Other portions of most of the vehicles have been supplied by the carriage-maker, and the result is sometimes almost ridiculously incongruous; the heavy leather work, dashboards, and other details evolved after generations of horse propulsion, still being retained, though the necessity of their existence has vanished. In this respect the small vehicle of de Dion and Bouton and the larger one of Bollée are to be highly commended, as most free from the trammels of precedent in carriage design, and as exhibiting more fully than others the idea of adaptation of means to end, regardless of practice in the construction of horse vehicles.

Motor vehicles have undoubtedly come to stay, or, rather, to go, but there is still much room for improvement. The improvement in roads will certainly have much to do with the improvement in the vehicles, and in this respect road construction and vehicle design must react upon each other.

The Jungfrau Railway.

SINCE 1889 several plans have been made for the construction of a railway by means of which tourists could reach the summit of the famous Swiss mountain peak known as the Jungfrau, hitherto reached only by experienced climbers assisted by capable guides; but the earlier schemes, involving cable traction, expensive tunnelling, and excessive grades, were never executed, and it remained for the latest plan of Herr Guyer Zeller, president of the northeastern railway system of Switzerland, to be carried to success.

Various accounts of this important and unique work, now approaching completion, have been given to the public, but one of the most elaborate is that recently presented before the German Railway Society by Dr. Wrubel, of Zurich, and published in *Glaser's Annalen*.

Although the altitude of the Jungfrau above sea-level (13,670 feet) is a little less than that of Pike's Peak, the origin of the Swiss road is lower than that of the American one; so that the Jungfrau road will have the greater vertical rise, the maximum grade being about the same in both instances,—*i. e.*, about 25 per cent. The great feature of the Jungfrau railway, however, is operation by electricity, instead of by steam locomotives, the current being derived from water power obtained from the two branches of the Lütschine, near Lauterbrunnen. Only a small volume of water is available, careful gaugings showing a flow of 6 cubic meters per second in summer and but one-third as much in winter. The fall, however, in two stages of 38 and 150 meters, gives to this small volume of water a maximum power of more than 11,000 h. p., and, as there is ample water during the tourist season, and the road is not to be operated in winter when the flow is diminished, there is no question about the sufficiency of the power-supply.

The electric system will consist of a three-phase current at 7,000 volts' pressure, which will be transformed to 500 volts for use in the electric locomotives, which, with the generators, are being built by Brown, Boveri & Co., of Baden. A portion of the electric system is already installed, the current being used for the purposes of railway construction, tunnelling, etc., and the feeding wires following the work as it advances.

An interesting feature of the scheme is that the grant of the concession to Herr Guyer Zeller and his associates included the requirement that the system should involve no injury to the health of passengers by the too rapid ascent into a rarefied atmosphere. A number of experiments were instituted to ascertain the physiological effect of a change of atmospheric pressure, at different rates of speed, persons of various ages and conditions being placed in chambers, from which a portion of the air was removed more or less rapidly; and, in view of the results of these experiments, and of data obtained from balloon ascensions, the authorities concluded to omit the health clause. The trouble of these tests might have been avoided, had the experience gained upon the Pike's Peak railway been considered, since the ascent there to an altitude of

14,147 feet in a few hours does no harm to the passengers. It is well known, moreover, that mere altitude is not the only element in producing ill effects, as the dread soroche of the Peruvian Andes is felt on the Lima and Oroya railway at points much below the town of Oroya, where the altitude is but 12,000 feet, and the ascent more gradual.

Although active work is in progress upon the Jungfrau road, the difficulties of construction will render its progress slow. It is expected that the Eiger glacier will be reached by 1900, but that the completion of the entire road will occupy five or six years.

The terminal of the road is not at the summit of the Jungfrau, that sharp peak being accessible only by a vertical lift; hence the last portion of the journey is to be performed in an electric elevator, the lift being 73 meters (240 feet), and delivering the passengers at the very summit.

The road is being constructed with steel cross-ties, the central rack rail being on the Strub system, and the electric locomotives are being designed with double motive power throughout and a quadruple system of brakes, both electrical and mechanical, there being one mechanical brake by which both sides of the central rail can be grasped, independently of any of the driving mechanism, thus affording a measure of security which renders failure highly improbable.

Water Transport and Grain Imports.

FOR several years there has been much agitation in various parts of Germany and Austro-Hungary in the matter of better and greater facilities for internal transport of merchandise, especially by means of canals and canalised rivers; and a number of schemes have been discussed, some of the more important of which have been noticed in these pages.

One of the reasons why there has been little more than talk thus far may be found in the conflict of interests concerned in the ultimate effects of such improvements in internal waterways.

In the Westphalia district the mining interests are seeking relief from the constant congestion in the facilities for transportation of coal, while the agricultural sections of western Europe look askance on anything which will benefit the competition of the grain from Hungary and southern Russia.

All these conflicting interests, however, may become united in contemplation of the common competitor which is found in the United States, and it may be that the necessity of meeting the importations of American grain by some reduction in continental transport expense is the factor which is to unite the opposing elements, and further the cause of internal waterways in central Europe.

It is doubtless with this object in view that Herr von Gunesch presented before the Austrian Society of Engineers a very full paper on the development of internal waterways in America, and their influence on its exports to Europe, and in the paper and discussion, published in the *Zeitschrift des Oesterr. Ingenieur Architekten Vereines*, some interesting features are brought out, especially in regard to the relations between engineering and commerce.

The paper contains a brief historical review of the development of the Erie canal, with sections of the channel, and plans of the capacity of locks at various dates, showing the continual increase in capacity, while tables are also given of the tonnage, etc., for the successive decades since 1837.

Coming more directly to the question at issue, Herr von Gunesch proceeds to compare transportation costs, especially for grain, between the United States and central Europe, and shows that, if in the United States the expenses of handling and breaking bulk are eliminated by the completion of the waterway communication between the great lakes and the ports of Europe, either by direct loading of seagoing vessels or seagoing barges, the competition will force Europe to do something to meet it.

Taking the figure deduced from Captain Symonds's report to the American Deep Waterways Commission, Herr von Gunesch shows that it will be possible to transport grain from Chicago to Laube,

the grain center of Moravia, by way of Hamburg, for practically the freight charge now made from Budapest to Laube, although the distance in the former case is about 6,000 miles and in the latter only 435 miles.

Herr von Gunesch then proceeds to show how, by the construction of a system connecting the Danube, Moldau, Elbe, and Vistula by canals, the present cost of transport from the grain fields of central Europe could be reduced to a figure which would meet the American competition. Hungarian grain could then be delivered at Hamburg as cheaply as American grain, while from Moravia the cost of transport would become less than half the present rate, and but little more than half the rate from Chicago to Hamburg.

The importance to central Europe of the construction of waterways for internal transport is now undoubted, and the paper to which we have referred shows that, while internal interests may be somewhat disturbed, the pressure of external competition will be too great to be resisted, and that engineers will doubtless soon be set to work constructing these new outlets for commerce.

A Powerful Crane.

THE port of Hamburg is already provided with several heavy cranes, but the most recent addition to the handling devices there installed is a powerful derrick-crane of 100 tons' (metric) capacity, constructed by the Duisberg Machine Works, for the ship-building yard of Messrs. Blohm & Voss, and illustrated and described in the *Zeitschrift des Vereines deutscher Ingenieure.*

Apart from its large capacity, the crane possesses several points of ingenious novelty, combining to a certain extent derrick and shears. The general construction of the crane proper is that of a braced jib, made up of lattice girders, and rotating upon a swivel base. The upper pivot is supported by three inclined pillars resembling shear legs, except that they are fixed, the vertical axis of the radial jib being as close to the edge of the quay wall as the diameter of the bottom bearing plates will permit. The upper part of the jib is divided, with a pivot joint in the lower member and a pair of screw connections in the upper girder, and by the action of the screws the radius of the jib may be varied so that the overhang can be made anything between 32.5 and 17 meters.

There are two separate systems of hoisting tackle, one operating with four parts of wire rope, and taking loads up to 30 tons, the other with eight parts of rope, for loads up to 100 tons. The general arrangement of the crane renders it especially adapted for the purpose of installing heavy machinery, boilers, engines, masts, etc., on vessels which may be floated up the side of the dock, and, as a fine piece of mechanical engineering, it is well worthy of study.

The New Terminal of the Orleans Railway.

IN a previous issue we called attention to the important plans made for a new terminal station in the heart of Paris, on the site of the ruined Cour des Comptes, and in the *Génie Civil* we now have further account of the station, as well as of the subway by which it is to be approached, and illustrations of the preliminary work of demolition and preparation.

The final design accepted by the company for the building is that of M. Laloux, and from the illustrations given there seems to be but little doubt that it will be an ornament to the city.

In the construction of the subway, which is to connect the new station with the present Orleans station at the Pont d'Austerlitz, a number of difficulties are to be encountered in the form of existing obstructions, for which other provision must be made.

At the present time both banks of the Seine have beneath them the main collecting sewers that receive the discharges of the smaller sewers which formerly delivered into the river, and, in order to make way for the railway tunnel, the collector on the left bank must be deviated from its present position. It is intended to carry the new main sewer under the boulevards Saint Germain and Saint

Michel, and this will remove it to some distance from the bank of the river. It will also be necessary to reverse the slope of the smaller sewers from the river bank inward, so that they will deliver into the new collector. Corresponding changes will be required in the gas and water pipes, and the cost of making all these changes forms an important item in the total expense.

The magnitude of this work is such that it can be shown in the technical journals only in its successive stages, and the principal points of the article above noted refer to the preparatory work, not only in reviewing the underground obstructions, but also in clearing the surface where the new buildings are to be erected. All along the quai d'Orsay the preparations for the subway construction are in evidence, while in the heart of old Paris, between the rue de Lille, the rue de Bac, and the rue de Bellechasse, the demolition of the ruins of the Cour des Comptes, which had remained almost the sole reminder of the Commune of 1870, is a scene which attracts much attention.

It is believed that the completion of this station will be of especial advantage, in that it will enable residents of the suburbs and of the country for some distance around Paris to make frequent visits to the city, as the terminal is to be so conveniently situated with regard to the principal business locations and other centres of interest that little or no time will be lost in traversing the city. Hence visits even of a single day can be made to advantage.

The work is intended to be entirely completed before the opening of the exposition of 1900, as the new terminal is to assist to a great extent in handling the crowds.

The total cost of the improvement is estimated at 40,000,000 francs, of which nearly one-half is for the construction of the subway and the diversion of the sewers and other obstructions, and nearly one-third for property damages and land purchases. The building of the terminal, it is estimated, will cost more than 9,000,000 francs.

The Grisoumetre.

AT the present time much attention is being given in the various mining districts on the continent to the subject of fire-damp and the best methods of preventing explosions in collieries where the production of dangerous gases is a possibility. In many of the districts careful records are kept of the relation of the production of gas to the variations in barometric pressure, in order that the fall in the pressure of the atmosphere may be used as a warning of possible danger; and in nearly every case care has been taken to investigate the liability of the mining explosives to ignite the mine gases. We have also noted at length the experiments of Heise and Thiem upon the conditions under which electric apparatus in mines may be a source of ignition of explosive gases, and, on the whole, this important subject is being very thoroughly investigated.

In France especially the work of studying the explosive nature of various mine gases has been carried on by Dr. Grehant, and, in a recent lecture published in the *Bulletin de la Société d'Encouragement*, he describes and explains very fully the action of his so called "grisoumetre," or apparatus for determining the proportion of combustible gas existing in a sample of mine air submitted for examination.

The principle of the grisoumetre is that of burning the combustible portion of the sample of air, by an incandescent spiral of platinum wire, measuring the reduction in volume, and deducing by the difference the proportion of fire-damp which must have been present. The measurement is accomplished by having the combustion chamber form the upper part of a graduated tube, so that the only observations necessary are readings of the graduations before and after the passage of the electric current; but special precautions have to be taken to insure the constancy of all conditions, such as temperature, pressure, etc., and the auxiliary devices for these purposes form essential parts of the apparatus, as Dr. Grehant clearly showed.

The apparatus should be carefully calibrated by the use of samples of gas whose composition is accurately known, after

which its use is very simple and rapid; as Dr. Grehant suggests, it should be used daily, thus enabling any marked deviation from the normal condition of the mine atmosphere to be noted at once. Dr. Grehant gives examples of four determinations of widely-differing mixtures, indicating the proportion of methane to within one-tenth of one per cent., each examination requiring but fifteen minutes.

In view of the great risks incurred by operating mines in which fire-damp is liable to appear, the trifling cost which the use of such an apparatus involves seems a very low rate of insurance to pay for the protection of property, to say nothing of the lives of the miners; and the general introduction of such a device in all gaseous mines cannot be too strongly recommended.

Marine Engine Shafts.

THERE is scarcely any element in machine design which is of greater importance than the main crank-shaft of a modern ocean steamer, the conditions of its operation and the serious consequences attending failure alike contributing to make its design and construction a matter demanding the best ability. The complexity of the problem has been greatly increased with the multiplication of cylinders and cranks which modern multiple expansion engines involve, and the magnitude, direction, and influence of the forces at work upon such a shaft constitute a factor of great uncertainty.

A paper upon this subject is contributed to a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* by Herr von Berling, of the Imperial shipyard at Kiel. It is a complete analysis of the various forces acting upon multiple crank shafts in actual service, the discussion being both graphical and analytical.

Considering the shaft first as a continuous girder, the manner in which any deflection between two bearings is transmitted to the portions between the other bearings is first discussed, after which the combined bending and twisting action of the cranks is taken into account, and computations made to show, not only the magnitude of the stresses induced in the shaft as a whole, but also the points of greatest stress, and therefore of greatest liability to breakage. The number and relation of cranks, as regards both angular position and longitudinal location on the shaft, are taken into account, computations being given for two cranks, either opposite or at right angles, as well as three and four cranks under conditions of actual practice.

The nature of the subject is such that only a general indication of the method of treatment can be given here, but the mathematical work is not complex, and the use of graphical diagrams render the application of the formulas easily intelligible, especially as worked-out examples are appended.

It is believed that an examination of the method which Herr von Berling has developed would, if generally applied, do much to diminish the number of shaft breakages at sea.

The Improvement of the Danube at Regensburg.

THE regulation of the Danube at and below the old imperial city of Regensburg, or, as it is sometimes called, Ratisbon, affords an excellent example of the general river-improvement work which is constantly being conducted throughout central Europe, and to which, as has been noted elsewhere, increasing attention is now being given. Incidentally the work at Regensburg shows the difficult conditions attending improvement works where old structures interfere with the introduction of what would otherwise be the best methods of reaching the desired end.

An official account by Herr Arthur Herbst of the work which has been done at Regensburg, is given, with illustrations and map in the *Oesterreichische Monatschrift für den öffentlichen Baudienst.*

The Danube at Regensburg is divided into two branches, separated by islands known as the *obere* and *untere* Wörth, and, at the wide stretch where the gap between the two islands occurs, there is an old stone arch bridge, dating back to the twelfth century, and connecting the city

proper with a suburb called the "Stadt am Hof."

This old bridge doubtless was placed at the widest point, in accordance with the well-known mediæval practice, in order that the massive piers and short-span arches should oppose a minimum resistance to the flow of water at time of freshets; but at present the location of the bridge prevents the improvement of the river from being carried to a point higher up stream, so that the regulation of the channel has been limited to the stretch below the bridge.

A large portion of the work which has been done on this portion of the stream consists of a contraction of the channel, building out the banks at points where the river had spread to too great a width, and confining the channel to definite limits best suited for the maintenance of a navigable water-way.

The especial reason for this portion of the work was that the double curve in the river, below the city of Regensburg, causes a tendency to divert the channel, which thus closely approaches now one bank, now the other, giving insufficient room for navigation, and creating shoals on the opposite sides. This work was accompanied by the necessary dredging, and, after the channel had been once regulated, the current was so directed as to maintain it. Interesting details of the methods of filling up the back shallows are illustrated, one being the filling of scows with stone in which pine trees were placed vertically with all the foliage on the bough, these scows being towed to the desired points and sunk. The weight of the stone retained the trees in position and made a network into which the dredged material from the channel was dumped, thus forming a bank not readily eroded by the current. At other points mattresses of fascines and brush work were used with gravel filling, the whole system, illustrated in the paper, forming an excellent example of river regulation works.

At the dock below Regensburg an excellent stone quay wall has been constructed, a foundation of piling having first been driven, upon which an outer timber coffer-dam wall was temporarily made, behind which a solid concrete permanent wall was built, giving for commercial purposes a river front well adapted to the needs of the city.

These works are noteworthy, not because of their magnitude or commercial value, but as an excellent example of the general river improvement going on in many parts of Europe in the interest of that system of cheap internal water-way merchandise transport the necessity of which is being felt more and more.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Accident.

An Erection Accident. Describes failure of roof trusses of the State Armory building at Newburg, N. Y. 600 w. Eng Rec—April 30, 1898. No. 19959.

Architectural Dangers.

Lessons from Fire and Panic. Thomas Blashill. Paper read at meeting of the Surveyors' Inst. at Manchester, Eng. Discusses points in construction tending to secure safety of the inmates. 7300 w. Builder—April 23, 1898. No. 20014 A.

Dome.

Erecting the Dome of the Rahway Reformatory. Illustrated description of construction of a metal dome 120 feet in diameter, 8 feet larger than that of St. Paul's, London. 1200 w. Eng Rec—May 14, 1898. No. 20215.

Domestic Architecture.

A Study of Domestic Architecture in the Eastern States of America in the year 1896. A. N. Paterson. Read at meeting of Royal Inst. of Brit. Arch'ts. Abstract. Describes various types, calling attention to special features due to climatic conditions, materials used and systems of heating. 1500 w. Arch, Lond—April 22, 1898. No. 20001 A.

Ecole des Beaux-Arts.

The Spirit of Design at the Ecole des Beaux-Arts. John Galen Howard. Presents some of the salient points of the scientific instruction, with the aim of forming a just idea of the province and influence of the school. 4000 w. Arch Rev—Vol V. No. III., 1898. No. 19965 F.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) A review of the present status of the work, with illustrations of some of the models of the buildings, and a plan of the area selected for the colonial exhibit. 2500 w. La Revue Technique—April 25, 1898. No. 20402 D.

Fire-Proof.

A New Fire-Proof Floor. Illustrated description of a new form of floor designed on the beam principle. The beams are made of "mackolite," the basis of the material being gypsum. 1000 w. Eng News—May 26, 1898. No. 20517.

Fire-Proof Construction and Prevention of Corrosion. William Sooy Smith. Considers the materials employed and the mode of construction of buildings, with a view to making them strong, safe and economical, and proof against destruction by fire and water; recommending a construction using "asbestic" as a covering and presenting its qualities. 3500 w. Jour W Soc of Engs—April, 1898. No. 20510 D.

Fire-Proofing of Warehouses. Frank B. Abbott. Discusses the means of protecting steel framed buildings from corrosion and fire. Urges the surrounding every structural member with concrete, leaving no air spaces externally or internally. Discussion. 14000 w. Jour W Soc of Engs—April, 1898. No. 20511 D.

Some Notes upon the Struggle for Survival between Burnt-Clay Fire-Proofing and Its Newly Arisen Rivals. Dankmar Adler. Part first notes the pauses that are sure to come in the development of industrial progress, and comments on the wisest way to meet the pause now reached by the burnt-clay fire-protective coverings, suggesting a study of the damages inflicted on the material by fire and the means of prevention. 2000 w. Br Build—May, 1898. Serial. 1st part. No. 20512 C.

High Buildings.

The High Buildings of the Ancients. From the St. Louis *Globe-Democrat*. Interesting account of laws, regulating the height of Roman buildings, long before the Christian era. 3500 w. Am Arch—April 30, 1898. No. 19992.

Library.

Record and Library Building for the City of Cologne. (Archiv und Bibliothek der Stadt Köln.) Plans, photographic views and detailed description of the fine new building for the archives and city library. 3000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—May, 1898. No. 20437 D.

Mechanical Plants.

Mechanical Plants of Large Buildings. Dankmar Adler. Reviews the requirements for the satisfying of which mechanical appliances and apparatus are essential, the great improvements made in recent years, the educational development of the expert engineer, &c., with discussion. 8500 w. Jour W Soc of Engs—April, 1898. No. 20508 D.

Municipal Buildings.

The Mairies of Paris. Fernand Mazade. Description, with many illustrations, of these edifices, and criticisms showing that they are usually ill-adapted to the purpose they are intended to serve. 4200 w. Arch Rec—April-June, 1898. No. 20098 C.

Notes on the Construction of Town Buildings. Howard Chatfield Clarke. A paper taken as read at the Manchester (Eng.) meeting of the Surveyors' Inst. Considers these buildings from the points of view of construction, materials, and cost. 3300 w. Builder—April 30, 1898. No. 20152 A.

Police Station.

A New York City Police Station. Illustrates a building for a force of nearly 150 men, officers, calls, patrol stables, and other special features. 1800 w. Eng Rec—May 7, 1898. No. 20092.

Reconstruction.

Strengthening the Walls of a Theatre. Describes the reconstruction of bulging walls and decaying roof trusses of the Madison Street opera-house, Chicago. 600 w. Eng Rec—April 30, 1898. No. 19960.

Roofs.

Novel Roof Construction. Owen B. Maginnis. Illustrates and describes an unusual form of trussed roof. 800 w. Ill Car & Build—May 13, 1898. No. 20324 A.

HEATING AND VENTILATION.

Fan System.

Heating and Ventilation of the Infirmary of the Indiana Reformatory, Jeffersonville, Ind. Illustrated description of a first-class fan system of heating and ventilation, which can be installed at small expense. Plans and data of the plant in the building named are given. 1100 w. Heat & Ven—May 15, 1898. No. 20365.

France.

The Application of Low Pressure Steam for the Heating of Dwelling-Houses and Public Buildings in France. An account of the introduction of this system of heating in France. 1100 w. Dom Engng—May, 1898. No. 20281 C.

Fuels.

The Working Value of Fuels. Thomas Fletcher. Reprinted from the London *Gas World*. Considers the heating of living rooms by coal gas and plant houses by coke fired boilers, where the ventilation is controlled, the figures being for average work. 1000 w. Met Work—May 7, 1898. No. 20084.

Furnace System.

An Efficient Furnace System. Illustrates an arrangement of a few risers to heat a number of rooms. 400 w. Eng Rec—May 21, 1898. No. 20317.

Greenhouse Heating.

Application of Heat to Greenhouse Structures. W. R. Beattie, in the *Columbus Horticultural Journal*. Describes a combination of steam and hot-water heating that the writer has found advantageous. 1300 w. Met Work—May 14, 1898. No. 20178.

Masonic Temple.

Heating of the Utica Masonic Temple. Illustrated description of a direct and indirect system in a 3-story and basement building. 1000 w. Eng Rec—May 21, 1898. No. 20316.

Post-Office.

Ventilation and Heating of the Omaha Post-Office. Illustrates the plant in a four-story public building covering 167 x 133 feet. Low-pressure exhaust steam is used, and a modified double-duct system is employed, with supplementary direct and direct-indirect radiation on the different floors. 1200 w. Eng Rec—May 7, 1898. No. 20093.

Railway Station.

Low Pressure Steam Heating Apparatus, Erie Railroad Passenger Station, Jamestown, N. Y. Plans showing the arrangement of the radiators, and the distribution of the surface in various parts of the building. Ill. 400 w. Heat & Ven—May 15, 1898. No. 20367.

School Heating.

Heating of the Roslyn, N. Y., School. Illustrates a small plant on the low-pressure indirect gravity system with sufficient direct radiation to counteract the heat transmitted by the walls and windows. 600 w. Eng Rec—April 30, 1898. No. 19961.

Ventilation.

Ventilation of Buildings. R. C. Carpenter. The first of a series of articles which will describe applications of various methods as practiced in France thirty or thirty-five years ago, and also give historical references to various systems. 2300 w. Heat & Ven—May 15, 1898. Serial. 1st part. No. 20366.

Warm Air.

Heating Buildings by the Warm Air System. J. J. Blackmore. Describing the conditions and methods of the most advanced practice in warm air heating, both for residences and public buildings, with numerous illustrations. 3000 w. Engineering Magazine—June, 1898. No. 20477 B.

PLUMBING AND GAS FITTING.

Business Methods.

How Should the Plumber Conduct his Business in Order to Make a Reasonable Profit? John J. Foy. Read at convention of Nat. Assn. of Plumbers, at San Antonio, Tex. On the changed conditions and advancement in this trade, the necessity of education and needed reforms. 1700 w. San Plumb—May 1, 1898. No. 20100.

Residence.

Plumbing in the Kunhardt Country Residence. Illustrates an elaborate installation for domestic supply, fire protection and drainage. 1600 w. Eng Rec—May 14, 1898. No. 20217.

Siphonage.

Recent Experiments in Trap Siphonage. William Paul Gerhard. An account of experiments made in Cologne, Germany, by Herr Unna, with the results. Ill. 4000 w. Am Arch—May 21, 1898. No. 20321.

MISCELLANY.

Aberdeen.

The Architecture of Our Large Provincial Towns—Aberdeen. An illustrated description of very interesting architecture, with some information of the city. 7000 w. Builder—May 14, 1898. No. 20334 A.

Competitions.

The Morality and Economy of Competitions. H. B. Cresswell. Read before the British Architectural Assn. Considers the system detrimental to the best interests of architecture and to the profession of architects. 3000 w. Arch, Lond—April 29, 1898. No. 20150 A.

Contract Relations.

The Relations between the Purchaser, the Engineer, and the Manufacturer. William H. Bryan. Discusses the mutual obligations and responsibilities of the parties with especial reference to the relations of engineer and architect. 3500 w. Am Soc of Mech Engs, No. 781—June, 1898. No. 20254 D.

Copyright.

Artistic Copyright—With Special Reference to Architects. Georges Harmand. The protection of copyright in architectural design, especially as it is regarded on the continent of Europe. 11400 w. Jour Roy Inst of Brit Arch'ts—April 9, 1898. No. 20175 B.

Gardening.

The Garden as an Adjunct to Architecture. R. Clipston Sturgis. Criticisms and suggestions relating to the treatment of grounds around dwellings. Ill. 4500 w. Arch Rev—Vol. V. No. III. 1898. No. 19964 F.

Government Architecture.

United States Government Architectural Work and Workers. Reviews the history of the United States government Department of Architecture, with the personnel and routine of workings. 7500 w. In Arch—April, 1898. No. 19985 D.

Heraldry.

Heraldic Drawing and Its Adaptation. J. D. Crace. Considers the qualities which should distinguish good heraldic drawing, presenting examples, and discussing their application to decorative effects. Also discussion. 6400 w. Jour Roy Inst of Brit Arch'ts—March 26, 1898. No. 20174 B.

Lighting.

Interior Lighting. (Reflected Lights, &c.) W. Eckstein. Read at meeting of the Architectural Assn., London. Discusses means of obtaining the best and most useful daylight, and gives much information of use to architects. Ill. 4800 w. Builder—May 14, 1898. No. 20335 A.

Monuments.

Preservation of Historic Monuments. Explains the control in Belgium over the demolition of ancient monuments or their repairs, when such are of a nature to change the style or character. 1800 w. Arch, Lond—May 6, 1898. No. 20244 A.

Preservation of Ancient Monuments. Gives the regulations in force in Sweden and Norway. 1700 w. Arch, Lond—April 22, 1898. No. 20002 A.

Preservation of Historic Monuments. There is in Austria no voluntary association for the protection of historic buildings, but the functions of such a society are undertaken by a commission. The protection given in Bavaria is also presented. 2200 w. Arch, Lond—April 29, 1898. No. 20151 A.

Review.

A Reminiscence of Architecture. A. A. P. Historical review of architectural remains in England, dating from the Conquest. 2300 w. Ill Car & Build—May 6, 1898. No. 20227 A.

William Morris.

The Art of William Morris. Russell Sturgis. Reviews a work on this subject by Aymar Vallance, and gives illustrations of his designs. 7500 w. Arch Rec—April, June, 1898. No. 20099 C.

CIVIL ENGINEERING.

BRIDGES.

Cantilever.

Cantilever Bridge Over the Theiss River at Tokaj, Hungary. Abstract translation of description by the designer, O. J. Marstrand, as published in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*. Ill. 600 w. Eng. News—May 26, 1898. No. 20520.

Centering.

The Centering for the Arch over the River at Vienna. (Das Lehrgerüst für die Wienfluss-Einwölbung.) Details and photograph of a well designed timber centering of 70 feet span. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, 1898. No. 20433 B.

Coffer Dams.

Practical Points on Coffer-Dam Work. J. B. Gordon. The writer's experience in stopping leaks, with some of the difficulties he met in the work on the bridge between Staten Island and New Jersey. 1200 w. Stone—May, 1898. No. 20378 C.

Drawbridge.

The Design of a Modern Drawbridge. Andrews Allen. Presents the design of the Calumet River Draw, for the Calumet & Blue Island Ry. Co. Ill. 2800 w. Wis Engr—Jan., 1898. No. 20277 D.

East River Bridge.

The Brooklyn Anchorage of the New East River Bridge. Illustrated description of the plant and methods of construction of an anchorage 114 feet high, resting on a platform 158 x 177 feet. 2800 w. Eng Rec—May 14, 1898. No. 20210.

Metallic Bridges.

The Erection of Metallic Bridges. Frank P. McKibben. Considers the various methods of erecting different forms of metallic bridges. Illustrations and discussion. 9000 w. Jour Assn of Engng Soc's—March, 1898. No. 19977 C.

Reconstruction.

Reconstruction of the Chicago & Northwestern Bridge, Clinton, Iowa. Engravings showing the main features of the reconstruction of four fixed spans of the single-track bridge over the Mississippi, with account of the work. 900 w. R R Gaz—May 20, 1898. No. 20299.

Temporary Bridge.

The Temporary Vauxhall Bridge. Photographic views, plan and elevation of central girders, with brief notes. 500 w. Engr, Lond—May 13, 1898. No. 20353 A.

Viaduct.

The Rock Creek Masonry Bridge, Washing-

ton, D. C. Describes novel features of 1341-ft. arch viaduct, designed by G. S. Morison. 900 w. Eng Rec—April 30, 1898. No. 19954.

Working Stress.

The Determination of the Safe Working Stress for Railway Bridges of Wrought Iron and Steel. E. Herbert Stone. Compares and discusses six systems for giving approximately the safe working stress for wrought iron, with discussion of results for steel and related matters of interest. 11500 w. Pro Am Soc of Civ Engs—May, 1898. No. 20395 F.

CANALS, RIVERS AND HARBORS.

Asia.

The Rivers of Asia. E. A. Sibold. Part first gives information concerning the rivers of the Sistan basin. Map. 1600 w. Ind Engng—April 16, 1898. Serial. 1st part. No. 20290 D.

Banks.

Protection of River Banks. Robert Grimshaw. Illustrated account of how river banks in Germany are protected. 2200 w. Engr, N. Y.—May 2, 1898. No. 20060.

Dam.

Steel Dam at Ash Fork, Arizona, A. T. & S. F. Ry. Illustrated description of a dam 184 ft. long on top, consisting of a series of triangular steel frames, resting on concrete foundations, and carrying steel face plates on the upstream face. 2500 w. Eng News—May 12, 1898. No. 20155.

The Management of Non-Parallel Motion and Deficient Operating Head in Bear Trap Dams by Auxiliary Constructions. An examination of the reasons which led to the use of auxiliary power in the Chicago Drainage Canal bear trap and in the Marshall bear trap. 2500 w. Eng News—May 26, 1898. No. 20519.

The Marshall Automatic Movable Dam. Illustrated description of a dam belonging to the "bear-trap" type and its operation. 2000 w. Eng News—May 26, 1898. No. 20521.

The Use of the Trapezoidal Formula in the Study of the Resistance of Masonry Dams. (Sur la Légitimité de la Régle dite du Trapèze dans l'Etude de la Résistance des Barrages en Maçonnerie.) Maurice Lévy. A discussion of the extent to which the trapezoidal formula may safely be used, having reference to the failure of the Bouzey dam. 2500 w. Comptes Rendus—May 2, 1898. No. 20417 D.

Danube.

The Regulation of the Danube at Ratisbon. (Die Donau bei Regensburg.) A. Herbst. A general account of the improvement of the river by limiting the width of the channel, by dredging, and by the construction of new quay walls. 500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—May 1898. No. 20436 D.

Detritus.

Sea-Beaches and Sandbanks. Vaughan Cornish. Abstract of a paper read before the Royal Geographical Society. Research upon the processes which distribute the detritus which enters the sea at its margin, and upon the behavior of the material distributed. Ill. 2000 w. Nature—May 12, 1898. No. 20326 A.

Drainage.

Drainage Plant of the Delta of the Niemen. (Installation de Desséchement du Delta du Niémen.) Fully illustrated description of the electrically operated system of scoop wheels by use of which a large volume of water is lifted a moderate height, recovering nearly 45,000 acres of land. 3000 w. 1 plate. La Revue Technique—April 25, 1898. No. 20400 D.

Dredging.

The Improvement of the Mississippi River by Dredging. H. St. L. Coppée. A fully illustrated account of the work of the Government engineers in removing bars, dredging channels, and regulating the navigation of the Mississippi. 4500 w. Engineering Magazine—June, 1898. No. 20480 B.

U. S. Government Hydraulic Dredges. Illustrates suction and jet dredges used on the Mississippi. 900 w. Eng Rec—May 14, 1898. No. 20211.

Flow.

The Flow of Water. H. S. Hele-Shaw. Illustrated account of experiments made to investigate the flow of water. 1500 w. Nature—May 12, 1898. No. 20325 A.

Levees.

The Levees of the Red River in Louisiana. F. M. Kerr. Abstract from paper presented to the Louisiana Engng. Soc., reviewing the past conditions of this valley, the influences at work and the progress made in protecting the land from overflow. 1800 w. Eng News—May 12, 1898. No. 20160.

Lighthouses.

Recent Progress in Coast Illumination. (Les Progrès Récents de l'Eclairage des Côtes.) Jean Rey. An illustrated account of the development of modern systems of lighting, from the compound lenses of Fresnel to the latest "lightning flash" method. 12000 w. Bulletin de la Société d'Encour—April, 1898. No. 20410 G.

The New Electric Lighthouse of Penmarch-Eckmuehl. (Finisterre.) C. Du Riche Preller. Illustrates and describes the distinctive features of this lighthouse of the Bay of Biscay. 1500 w. Engng—May 6, 1898. Serial. 1st part. No. 20229 A.

Madras.

Advance Madras! An account of harbor improvements in this part of India which have been carried out in the face of great natural difficulties. 1000 w. Ind Engng—April 2, 1898. No. 20079 D.

Madras Harbor. Discussion of the improvement in harbor facilities. Part first considers the boat basin project. 3300 w. Ind Engng—April 16, 1898. Serial. 1st part. No. 20291 D.

Mountain Streams.

The Regulation of Mountain Streams. (Ueber die Regulierung von Gebirgswässern). F. Wang. Describing the methods used in Galicia, Bohemia, and the Tyrol for the protection of

the banks of mountain streams from erosion in times of overflow. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—May, 1898. No. 20438 D.

Nicaragua Canal.

The Nicaragua Canal Enterprise. William Ludlow. Extract from article in Harper's Magazine for May, discussing the "Trans-Isthmian Canal Problem." 1400 w. Eng News—May 5, 1898. No. 20074.

Ship Canal.

A Ship Canal to the Sea. H. S. Canby. Discusses the question of transportation, favoring the construction of a ship canal, and considering the new lock invented by Chauncey N. Dutton. 2000 w. Yale Sci M—April, 1898. No. 20035 C.

On the Great Lakes. F. W. Fitzpatrick. Illustrated presentation of the magnitude of the Great Lakes and their commerce. 3700 w. Cos—May, 1898. No. 20096.

IRRIGATION.

Barrage.

Special Repairs to the Barrage. W. E. Garstin. From the Administration Report of the Irrigation Department, Egypt. Particulars regarding the operation of stock-ramming and cement-grouting as carried out on the Nile Barrages. 3800 w. Ind Engng—April 9, 1898. No. 20187 D.

Mexico.

Canal Irrigation in Mexico. Hunter Morrison. Explains the system of the Tlahualilo company of Mexico, the difficulties in the accomplishment of the work, the administration and operation. 1700 w. Yale Sci M—May, 1898. No. 20266 C.

Seepage.

The Effect of Temperature on the Seepage of Water from Irrigation Canals. A collection of information from various sources, bearing upon the losses of water by absorption, evaporation, &c. 1500 w. Eng News—May 12, 1898. No. 20157.

MISCELLANY.

Beams.

Beams of Materials of Variable Coefficients of Deformation. (Träger aus Materialien von Veränderlichem Formänderungs-Coefficienten). Josef Anton Spitzer. With a special discussion of the conditions immediately preceding the instant of rupture Two articles. 1 plate. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, May 6, 1898. No. 20432 each B.

Cement.

Comparison of American and Foreign Portland Cements. W. W. Maclay. Comments on methods of testing and quotations from those who are considered among the highest authorities on the subject. 2200 w. Munic Engng—May, 1898. No. 20030 C.

Improved Portland Cement. John W. Dickinson. Explains what Portland cement is, and the essentials of a perfect product, showing the great advance that has been made by the American manufacturer, with report of comparative tests, and general discussion. 5500 w. Jour W Soc of Engs—April, 1898. No. 20509 D.

The Candlot Oscillating Grate for Cement Kilns. Frederick H. Lewis. Illustrates a grate, used in France, for improving the draft and preventing balling in shaft kilns. 400 w. Eng Rec—May 21, 1898. No. 20312.

The Standardization of Cement Testing. Editorial comment on the questions submitted by the Am. Soc. of Civ. Engs. discussing the merits of the enterprise and the value of the steps being taken for its accomplishment. 2500 w. Engr, Lond—May 13, 1898. No. 20350 A.

Columns.

An Investigation of the Strength of Columns, Leading to Some New Formulas. Carl G. Barth. Submits a new and purely rational formula for the proper working load on a column, and the arguments sustaining it. 4800 w. Jour Assn of Engng Socs—April, 1898. No. 20505 C.

Contracting.

The Right to Withdraw Erroneous Bids. Editorial review of decision of U. S. Circuit Court affirming contractor's right to withdraw bids containing manifest errors, before contract is made. 900 w. Eng Rec—April 30, 1898. No. 19952.

Contract Relations.

See Architecture and Building, Miscellany.

Lime.

Lime, Mortar and Cement. Their Composition and Analyses. W. J. Dibdin. Part first deals with the characteristics of various limes. 1500 w. San Rec—April 29, 1898. Serial. 1st part. No. 20085 A.

Office Methods.

Index System in City Surveyor's Office, Hartford, Conn. Frederick L. Ford. Illustrates the card index for field notes and drawings. 900 w. Eng Rec—May 7, 1898. No. 20091.

Painting.

Testing Oil Paints on Iron. Dr. H. Lolsner. Gives a description of the testing method employed by the writer, which is simple and yet may be called a crucial one. 1000 w. R R Car Jour—May, 1898. No. 20117.

Pile-Driving.

Some Instances of Piles and Pile-Driving, New and Old. Horace J. Howe. A record of facts and experiments from the experience of the writer, with quotations from many authorities, and discussion. 2350 w. Jour Assn of Engng Socs—April, 1898. No. 20506 C.

Projects.

Unprofitable Engineering Projects in Western America. A. G. Allan. Showing the folly of investing in any scheme without the fullest investigation. Both good and bad schemes are discussed and illustrated and the wisdom of obtaining reliable information emphasized. 3500 w. Engineering Magazine—June, 1898. No. 20478 B.

Roads.

Road Materials and Construction. W. M.

Watson. Reviews various systems of construction, referring to the old Roman roads, and later methods used by Macadam and others. 1300 w. Can Eng—May, 1898. No. 20193.

Surveying.

State Boundaries. Abstract from a paper by Henry B. Wood, read before the Boston Soc. of Civ. Engs. Description of township and state boundary surveys in Massachusetts. 2500 w. Eng Rec—May 14, 1898. No. 20212.

Tacheograph.

The Ziegler-Hager Tacheograph. Illustrated description of a surveying instrument, the chief merits being that horizontal distances and vertical heights are read off at the same time, that there are no calculations, that the instrument checks itself, and that the operations require very little time and skill. 800 w. Engng—May 6, 1898. No. 20230 A.

Triangulation.

The Triangulation of Bronx Borough, New York City. William S. Dalrymple. Description of the work, with map. 2000 w. Eng News—May 19, 1898. No. 20270.

Wood-Borers.

Marine Wood-Borers. Charles H. Snow. Illustrated description of the animals and their manner of working, their reproduction and development, some of the methods of protection which have proved most successful, &c. 12000 w. Pro Am Soc of Civ Engs—May, 1898. No. 20396 F.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Bicycles.

Reports on Bicycles. Information in the interests of trade concerning Norway, China, and Korea. 2000 w. Cons Repts, No. 125—May 26, 1898. No. 20385 D.

British Empire.

The British Empire: Its Resources and Its Future. John Lowles. A survey of the British Empire, showing the progress of the colonies, and containing interesting information of the products, resources and future prospects. Discussion. 13300 w. Jour Soc of Arts—April 22, 1898. No. 19974 A.

Cape Colony.

Commercial Conditions in Cape Colony. Concerning dock facilities, freight rates, how to sell goods in South Africa, openings for trade, labor, &c. 1800 w. Cons Repts, No. 119—May 19, 1898. No. 20265 D.

China.

Opening of Inland Water Routes in China. Extract from a Shanghai journal, on the consent of the government to admit foreign and native steamers to all inland waters, and the effect it will have on trade. 1100 w. Cons Repts, No. 121—May 21, 1898. No. 20318 D.

The Foreign Trade of China in 1897. Account taken from the Returns of Trade drawn up by the Imperial Maritime Customs. 1600 w. Bd of Trd Jour—May, 1898. No. 20387 A.

Cuba.

Future Industrial Opportunities in Cuba. Wilfrid Skaife. A discussion of the commercial, manufacturing, and industrial possibilities of the island under a secure and stable government. 3500 w. Engineering Magazine—June, 1898. No. 20471 B.

Egypt.

The Development of British Trade with Egypt. Information from the Annual Report of the British Chamber of Commerce of Egypt for 1897, containing many suggestions for retaining and advancing trade in Egypt. 2800 w. Bd of Trd Jour—May, 1898. No. 20388 A.

Guatemala.

Guatemala Trade-Mark and Patent Laws. A copy of the principal articles of the new laws. 4200 w. Bul of Bureau of Am Reps—April, 1898. No. 20177 C.

Industrial Relations.

Possibilities of the Present Industrial System. Paul Monroe. Illustrated description of the National Cash Register Factory at Dayton, Ohio, and its methods, based upon inspection and conversations with employés. 6000 w. Am Jour of Soc—May, 1898. No. 20201 D.

Japan.

Foreign Trade of Japan in 1897. Facts showing remarkable increase and the tendency of Japan to become a manufacturing country. 700 w. Bd of Trd Jour—May, 1898. No. 20392 A.

Japan as a Market. W. R. Thompson. Reviewing the opportunities for trade and the chances for American manufactures. 1000 w. Mfrs Rec—May 27, 1898. No. 20397.

The Foreign Trade of Japan for 1897. Figures taken from the *Japan Weekly Mail*, which present the aspects to which the Japanese attach the most importance. 600 w. Engng—May 6, 1898. No. 20232 A.

Limited Liability.

The 'Limited Company' Craze. S. F. Van Oss. Reviews some of the influences on commercial efficiency and business morality and the economic effects. 6800 w. Nineteenth Cent—May, 1898. No. 20200 D.

Madagascar.

The Trading Ports of Madagascar. Information concerning the principal trading ports of the island, communication by steamer, &c. 2000 w. Bd of Trd Jour—May, 1898. No. 20391 A.

Oriental Trade.

Notes from the Orient. Extract from a letter to Rogers, Brown & Co., written by their representative in Yokohama, Japan, explaining the difficulties in the way of trade, the methods of work there, and other matters of interest, especially to the iron trade. Ill. 3500 w. Foundry—May, 1898. No. 20220.

Philippines.

The Philippine Islands. Information regarding the area, population, exports and general trade. 1800 w. Cons Repts, No. 107—May 7, 1898. No. 20077 D.

Trade and Industry of the Philippines. Information with regard to the economic condition of these islands, taken from the most recent reports of the British Consular officials at Manila and other ports. 700 w. Bd of Trd Jour—May, 1898. No. 20389 A.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Table showing fluctuations in quotations from Oct. 1, 1895, to May 1, 1898, with remarks on the "spring rise" in prices. 4800 w. Bradstreet's—May 7, 1898. No. 20081.

San Jose Scale.

German Restrictions on United States Fruit. Report of the decree controlling the admission of live plants, to prevent the spread of San José scale. 600 w. Cons Repts, No. 111—May 11, 1898. No. 20163 D.

Tariff.

Tariff Changes and Customs Regulations. Russia, France, Portugal, Spain, Italy, Chile, United States, Guatemala, Peru, Canada, and British Guiana. 4800 w. Bd of Trd Jour—May, 1898. No. 20393 A.

Trade-Marks.

Trade-Marks in Hungary. A translation of the rules concerning the registration of trade-marks now in force in Hungary. 600 w. Cons Repts, No. 125—May 26, 1898. No. 20386 D.

Trade Statistics.

British and German Trade in 1897. A comparison of the leading branches of trade of both countries and their relative development. 1600 w. Engng—April 22, 1898. No. 20016 A.

Water-Ways.

The Development of American Waterways, and their Influence upon European Exports. (Die Entwicklung der Nordamerikanischen Wasserstrassen und deren Rückwirkung auf den Export nach Europa.) An address by Herr Rudolf Ritter von Gunesch, showing the influence which cheap water-carriage will have upon competition, and urging the importance of internal waterways in central Europe. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—April 15, 22, 1898. No. 20430 each B.

West Indies.

Cuba and Puerto Rico. Summary by the Bureau of Foreign Commerce, which will appear in the Review of the World's Commerce, 1896–7, printed in advance in response to a demand for information concerning the Spanish West Indies. 7500 w. Cons Repts, No. 117—May 17, 1898. No. 20264 D.

Internal Resources of the West Indies. H. Guzman. Information concerning the agricultural products, ports, trade with the United States, and the importance of the reconstruction of the U. S. merchant marine. 2800 w. Bul of Bureau of Am Rep—April, 1897. No. 20176 C.

Wharfage.

Reduction of Wharfage Dues in France. Reports a new law, supplemental to the one that went into effect Dec. 31, which is designed to extend the advantages of a reduction of wharfage to those vessels unfavorably affected by the previous law. 800 w. Cons Repts, No. 118—May 18, 1898. No. 20263 D.

CURRENCY AND FINANCE.

India.

India and Her Currency. Edward Sassoon. Reviews the history of the causes that led to the closing of the mints in India, and the monetary affairs from that time, discussing the policy pursued, various phases of the question, the difficulties and the effects. 10000 w. Jour Soc of Arts—May 13, 1898. No. 20329 A.

The Indian Currency Commission. W. R. Lawson. A discussion of the various sides of the currency question and the points to be brought before the commission. 6800 w. Bankers' Mag, London—May, 1898. No. 20504 A.

Japanese Investments.

Foreign Capital and Japanese Investments. Sets forth the adverse circumstances and conditions affecting commercial speculations in Japan. 1800 w. Engr, Lond—April 22, 1898. No. 20025 A.

LABOR.

Compensation Act.

The Cost of Insurance under the Workmen's Compensation Act. Discussing the effect of this act which will be inaugurated in England on July 1st, especially as it bears on the gas industry, indicating how the insurance company's view of the subject has been formed. 2000 w. Jour Gas Lgt—May 17, 1898. No. 20383 A.

Invention.

Does Invention Lessen Employment? Remarks on information from the Report of the Commissioner of Patents for 1897, showing that invention increases employment. 2500 w. Gunton's Mag—May, 1898. No. 20111 C.

Machinery.

Men and Machinery. Starr Hoyt Nichols. Tending to show that the effect of machinery instead of injuring workmen and lessening their opportunities, is really the deliverer of mankind from evil and poverty, and tends to the general welfare. 3000 w. N Am Rev—May, 1898. No. 19981 D.

Municipal Ownership.

See Municipal Engineering, Gas Supply.

Strike.

South Wales Colliers' Strike. A statement conveying the views of the employers in the Monmouthshire and South Wales Coal-owners' Assn., on the strike of colliery workmen. 2700 w. Engng—April 29, 1898. No. 20140 A.

The Coal Strike. Statement of affairs relating to the coal strike in Wales, reporting disorganization amongst the colliers, and the lack of effective leaders. 2300 w. Engr, Lond—April 22, 1898. No. 20027 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Chromium.

The Electromotive Properties of Chromium. (Ueber das Elektromotorische Verhalten des Chroms.) A paper by Dr. Hittorf before the Leipzig meeting of the Electrochemical Society, showing the different electrical properties possessed by chromium under different conditions, 5000 w. Zeitschr Elektrochemie—May 5, 1898. No. 20458 H.

Electro Chemistry.

The Electro-Chemical Industries of England. John B. C. Kershaw. Part first gives a review of the progress made in the last twenty years, with views and remarks concerning the Castner-Kellner Alkali Works, at Weston Point, Eng. 1200 w. Elec, N. Y.—May 18, 1898. Serial. 1st part. No. 20285.

The Relation of Chemistry to Electrical Engineering. C. Fred Burgess. The importance of the science of electro-chemistry, and the close relation and important developments to be looked for in the near future. 2700 w. Wis Engr—Jan., 1898. No. 20276 D.

Electrolysis.

Hydrolytic and Electrolytic Dissociation. (Ueber Hydrolytische und Electrolytische Dissoziation.) Dr. G. Platner. A general review of preceding investigations, together with the author's own results in the electrical dissociation of solutions of salts, considered from a chemical point of view. 2000 w. Elektrochemische Zeitschr—May 1, 1898. No. 20459 H.

Notes on the Electrolysis of Chloride of Calcium Solutions. (Beitrag zur Kenntnis der Elektrolyse von Chlorcalcium-I ösungen.) H. Bischoff and F. Foerster. A full account of experimental investigations, using different currents and solutions. 4000 w. Zeitschr f Elektrochemie—April 20, 1898. No. 20457 H.

Electrolytic Soda.

The Hargreaves-Bird Electrolytic Soda Process. Illustrated description of apparatus and process. 1200 w. Eng & Min Jour—May 21, 1898. No. 20323.

Metallic Oxids.

Electrolytic Production of Oxygen Compounds of the Metals. Experiments showing that considerable economy in working can be effected in many industrial processes by care in the choice of electrodes and in the composition and density of the electrolyte. 1100 w. Elect'n, Lond—April 29, 1898. No. 20148 A.

LIGHTING.

Carbons.

Electric Light Carbons. (Kohlen für Electrisches Licht.) Francis Jehl. Describing the various processes used for making electric light carbons, and the successive improvements which have been made. 1800 w. Der Electro-Techniker—April 30, 1898. No. 20463 B.

Efficiency.

The Real Meaning of Incandescent Lamp Efficiency. Francis W. Willcox. An explanation of the terms and the basis for estimating the efficiency. 1800 w. Elec Wld—May 14, 1898. No. 20181.

Enclosed Arc.

The Jandus Lamp. (Die Jandus-Lampe.) Report of tests upon the Berlin-Frankfort railway giving photometric results of the Jandus enclosed arc. 1200 w. Der Electro-Techniker—April 30, 1898. No. 20464 B.

Filaments.

Carbonization of Filaments by Electricity. L. S. Powell. Describes an electric method devised for this purpose by the writer, with account of some experiments made to test its practicability, and suggestions for further investigations. 2700 w. Elec Rev, Lond—May 13, 1898. No. 20344 A.

Lamps.

Trimming and Cleaning of Enclosed Arc Lamps. J. H. Hallberg. Presents the importance of this work as affecting the efficiency and suggests a system for doing it. 1300 w. Elec Rev, N. Y.—May 11, 1898. No. 20095.

Lighthouse.

See Civil Engineering, Harbors.

Lighting Effects.

Electric Lighting as Applied to Architecture. T. Ekin. Read at meeting of the Architectural Assn., London. Considers the lighting of buildings by the incandescent electric lamp, dealing with the distribution, the artistic effect, wiring, &c. 2300 w. Arch, Lond—May 13, 1898. No. 20336 A.

Lighting Plant.

The Electric Lighting Plant of the University of Michigan. Henry S. Carhart. Brief illustrated description of interesting features. 1100 w. Elec Wld—May 7, 1898. No. 20061.

Meters.

The Care and Testing of Alternating Current Recording Meters. R. H. Sterling. Deals with the Shallenberger type of the recording ampere-hour meter for alternating current. Ill. 2000 w. Am Elect'n—May, 1898. No. 19970.

Municipal Lighting.

Municipal Electric Lighting.—A Reply to Prof. Commons. Horatio A. Foster. The writer favors private ownership, and defends his arguments, discussing opinions advanced by the writer named. 2500 w. Elec Eng, N. Y.—May 12, 1898. No. 20168.

Resistances.

Commercial Forms of Electrical Resistances. Ll. B. Atkinson: Reviews the various types of electrical resistances used on light and power circuits, with special reference to a new material, "relugite." Ill. 3000 w. Elect'n, Lond—April 22, 1898. No. 20070 A.

Safety Attachment.

Protection for Edison Three-wire and Other Balanced Systems of Electrical Distribution.

Eustace Oxley. Explains the disastrous results that may follow the blowing of the neutral fuse, and describes and illustrates a simple safety attachment for a three-pole switch devised by the writer. 1400 w. Elec Eng, N. Y.—May 5, 1898. No. 20047.

Shades.

Conical and Spherical Shades. I. C. Thompson. Gives results of experiments made for the purpose of comparison. 900 w. Elec Eng, N. Y.—May 12, 1898. No. 20171.

Transformers.

Transformers v. Dynamos. Editorial comment on progress in England in electric lighting, with consideration of whether it is better to generate currents of high potential with a dynamo and transmit them direct, or to generate low-tension currents, throw them up with a transformer, and then transmit them. Favors the high-pressure dynamo. 1800 w. Engr, Lond—May 13, 1898. No. 20354 A.

Wimbledon, Eng.

The Wimbledon Electric Lighting Scheme. A. H. Preece. Read at meeting of the Incorporated Assn. of Municipal and County Engs. Description of the system that has been adopted, plant, mains, cost, etc. 2500 w. Elec Eng, Lond—May 13, 1898. No. 20338 A.

Wiring.

A Mechanical Computer of Fall of Potential. William Hand Brower, Jr. Describes a simple mechanical device for the solution of wiring problems, particularly convenient in calculations of conductor systems supplying current to movable receivers, or where the current demanded by fixed receivers may vary. 1700 w. Elec Wld—May 21, 1898. No. 20268.

"Free" and "Easy" Payment Systems of House Wiring. V. Zingler. Sets forth the scheme of John H. Rider to secure easy payment and compares it with the alternative scheme of the National Electric Free Wiring Co. 1500 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20006 A.

POWER.

Armature Reactions.

Armature Reactions in a Continuous Current Dynamo. C. A. Bessey. Reports results of a study of armature reactions, made at the Univ. of Nebraska. 500 w. Elec Eng, N. Y.—May 12, 1898. No. 20169.

Brush Holders.

Carbon Brush holders. Ernest Kilburn Scott. Gives a few of the rules which govern the application of carbon brushes, and also describes some of the leading types. Ill. 1200 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20012 A.

Combination Plant.

Continuous and Three Phase Current Plant. (Gleichstrom-Drehstrom-Speicheranlage.) The plant is installed in Hamburg warehouses, the three-phase current being used for motors, and the continuous current in connection with accumulators. 1200 w. Elektrotech Zeitschr—April 21, 1898. No. 20451 B.

Commutation.

Experiments in Commutation in Dynamos and Motors. W. H. Everett, and A. H. Peake. A short account of work in this field carried out in the electrotechnical laboratory of University College, Nottingham. Ill. 1500 w. Elect'n, Lond—April 22, 1898. No. 19999 A.

Cranes.

Electric Cranes. J. G. Statter. Abstract of a paper read before the Northern Soc. of Elec. Engs., England. Considers the lifting and transportation of loads by electrical energy, and the belt system. Also editorial. Ill. 6000 w. Elect'n, Lond—April 22, 1898. No. 19998 A.

Distribution.

Some of the Economic and Practical Aspects of Electrical Power Distribution in Factories. H. A. Mavor. Abstract of a paper read before the Inst. of Engs. & Shipbuilders. Considers factories where the power required is upward to 50 h. p., and where it is produced on the consumer's premises. 2300 w. Ir & Coal Trds Rev—April 29, 1898. No. 20126 A.

Dynamos.

Dynamo Troubles. Percy Donsville. Read before the Hamilton Assn., C. A. S. E. Some points which should be considered in placing and caring for dynamos and motors. 2500 w. Mines & Min—May, 1898. No. 20064 C.

Efficiency.

Measurement of the Efficiency of Continuous Current Electric Machines of all Powers. P. Dupuy, in *L'Eclairage Electrique*. A method of determining the efficiency which necessitates the use of two similar machines 500 w. Elec Rev, Lond—April 22, 1898. No. 20011 A.

Electrical Plant.

Electrical Plant of Macdonald Engineering Building, McGill University, Montreal. Illustrated description of this plant which has been extensively enlarged and altered. 1200 w. Can Elec News—May, 1898. No. 20082.

Electric Energy.

The Cost of Electric Energy. Editorial discussion of the subject, referring to information in paper of Robert Hammond. 2000 w. Engng—April 29, 1898. No. 20141 A.

The Cost of Generation and Distribution of Electrical Energy. Robert Hammond. Full paper read before the Inst. of Elec Engs., London. Discussion of the subject presenting a summary of the returns of undertakings in the United Kingdom. 55000 w. Pamphlet—British Inst. of Elec Engs. No. 20162 G.

The Cost of Generation and Distribution of Electrical Energy. Abstract of discussion by members of the Inst. of Elec. Engs. in connection with Mr. Hammond's paper. 7000 w. Elect'n, Lond—April 29, 1898. No. 20147 A.

The Distribution of Electrical Energy in Paris. J. Laffargue. Reprint of an article appearing in the Paris supplement of the *Contract Journal*. Part first reviews the conditions, giving map showing the distribution and positions of sections and considers the various networks. Ill. 1300 w. Elec Eng, Lond—April 29, 1898. Serial. 1st part. No. 20144 A.

The Distribution of Electrical Energy in Germany. J. Laffargue. Abstract of paper read before the Société Internationale des Électriciens. Gives general information with examination of some of the stations. 2300 w. Elec Rev, Lond—April 29, 1898. No. 20153 A.

Electric Mining.

See Mining and Metallurgy, Mining.

Flywheel-Dynamos.

Patin's New Flywheel-Dynamo. L. Bayly. Illustrated description. 800 w. Elec Rev, N. Y.—May 4, 1898. No. 20055.

Induction.

The Induction Motor. Alfred E. Wiener. The principles of the rotary field are clearly and accurately explained without the aid of mathematics. Ill. 1400 w. Am Elect'n—May, 1898. No. 19967.

Interrupter.

A New Interrupter for Induction Coils. V. Cremieu. Note presented to the Académie des Sciences. Illustrated description of apparatus for overcoming the inconveniences arising from the induced electromotive forces, of opposite nature, not being equal in value. 500 w. Elec Rev, Lond—April 29, 1898. No. 20154 A.

Interruptions.

The Prevention of Interruptions to Electricity Supply. Leonard Andrews. Read before the Inst of Elec. Engs., England. Discussing the causes and needed improvements, to guarantee an absolutely constant supply to every one, explaining the way the problem has been solved at Hastings. Ill. 4800 w. Elect'n, Lond—May 6, 1898, No. 20246 A.

Mining Motor.

See Mining and Metallurgy, Mining.

Motor.

A Universal Motor and Dynamo. Description, with working drawings, of a combined direct-current dynamo, alternator and rotary converter. 3200 w. Am Elect'n—May, 1898. No. 19969.

Single Phase Induction Motor. Charles Proteus Steinmetz. Considers load and speed curves; starting devices of various forms are investigated and the effect they have upon the action of the motor. Discussion. 18500 w. Trans Am Inst of Elec Engs—Feb., 1898. No. 19950 D.

Power Companies.

Electric Power Companies and Their Relation to Municipalities. Abstract of an address by Albion E. Long, delivered at Purdue University. Considers the relation of the company to the station producing the current and to the public. Does not approve municipal ownership. 1800 w. St Ry Rev—May 15, 1898. No. 20206 C.

Power Plant.

A Pacific Coast Power and Light Station—Los Angeles Street Railway Power Plant. Illustrated detailed description. 2000 w. Power—May, 1898. No. 20052.

Power Station.

The Hunt Power Station, Cincinnati, Ohio. Bert L. Baldwin. Illustrated description of a plant, showing what can be done in the way of remodeling an old plant. 1700 w. St Ry Jour—May, 1898. No. 20038 D.

Standardizing.

The Standardizing of Generators, Motors and Transformers. A discussion, opened by E. W. Rice, Jr. Also discussion at Chicago. 15000 w. Trans Am Inst of Elec Engs—Feb., 1898. No. 19949 D.

Station Records.

Electric Light and Power Station Records. Illustrates and describes Macrea's apparatus and its operation. 1200 w. Elec Eng, N. Y.—May 5, 1898. No. 20046.

Three-Phase Motors.

The Application of Three-Phase Currents. (Application des Courants Triphasés.) Description of the installation of a series of three-phase current motors at the Pernot biscuit bakery at Dijon. 1200 w. Le Génie Civil—April 23, 1898. No. 20405 D.

Transmission.

Erecting a High Voltage Transmission Line. S. H. Dailey. First half of an article, the laying out of the line and gaining of poles being treated. Ill. 2400 w. Am Elect'n—May 1898. Serial. 1st part. No. 19968.

Water-Power Plant.

St. Anthony Falls Water-Power Plant. Illustrated description of the large plant for furnishing power to the electric railways of St. Paul and Minneapolis. 3500 w. Am Elect'n—May, 1898. No. 19966.

TELEGRAPHY AND TELEPHONY.

Cables.

Electric Cables with Dry-Air Circulation. A. Barbarat. Abstract of a paper read before the Société Internationale des Électriciens. Describes the system of telephone cables employed at present in Paris. The telephone network is entirely underground, and the cables are ordered with paper insulation and dry-air circulation. 800 w. Elect'n, Lond—May 13, 1898. No. 20342 A.

Exchanges.

Large Opposition Telephone Exchanges. Considers the situation at St. Louis, Mo., as it existed before the entrance of the opposition company, and contrasts its financial features with the record of Detroit's exchange. 4800 w. Elec Engng—May 15, 1898. No. 20219.

Receiver.

Morse Receiver for the Argentine Telegraph System. (Morse Farbschreiber der Argentinischen Telegraphenverwaltung.) Describing the Tribelhorn receiver with automatic release, as used in Argentina. 1500 w. Elektrotech Zeitschr—April 28, 1898. No. 20453 B.

Space Telegraphy.

Automatic Receiver for Hertzian Wireless Telegraphy. (Poste Recepteur Pour la Télégraphie Hertzienne sans Fils.) E. Ducretet. A receiver to be used in connection with the Branly Coherer, recording the message in

Morse signals on paper strip. 1000 w. Comptes Rendus—May 2, 1898. No. 20419 D.

Some Facts about Wireless Telegraphy. Relates to the experiments that are being conducted in England by Mr. Marconi, with reference to work in other countries. 2300 w. Elec Rev, Lond—April 22, 1898. No. 20009 A.

Wireless Telegraphy. An editorial calling attention to some of the practical difficulties involved. 1400 w. Elect'n, Lond—May 13, 1898. No. 20341 A.

Vision.

Electric Vision at a Distance. (Der Elektrischer Fernseher.) A description of the apparatus of the Pole, Szczepanik, which is claimed to enable the electrical transmission of visual images to be accomplished. 2000 w. Die Elektrizität—April 16, 1898. No. 20461 D.

MISCELLANY.

Accumulators.

The Making of Lithanode Accumulators. Illustrated description of the process of making lithanode cells. 900 w. Elec Rev, Lond—May 13, 1898. No. 20345 A.

The Ribbe Accumulator. (Der Ribbe-Akkumulator.) This new storage battery is constructed with perforated celluloid plates to support the paste in such a manner as to render the cells much less liable to injury by transportation or rough handling. 1200 w. Etektrochemische Zeitschr—May 1, 1898. No. 20460 H.

Alloys.

Electrical Alloys. Rollo Appleyard. A summary of the investigations made in Germany to determine the mechanical and electrical permanence of the cheaper alloys used for resistance coils. 1200 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20008 A.

Alternate Currents.

Alternate Current Workings. Donald H. Fry. The first of a series of articles aiming to make clear some points in alternating currents not generally understood, and to show wherein they differ from direct currents. Ill. 3000 w. Jour of Elec—April, 1898, No. 20516.

On a Simple Approximate Method of Determining the Harmonic Components of a Graphically Given Complex Harmonic Wave. Edwin J. Houston and A. E. Kennelly. A method serviceable to engineers rather than to mathematicians, for finding the amplitudes of the harmonic components in an alternating current wave. 1200 w. Elec Wld—May 14, 1898. No. 20180.

Electric Furnaces.

Electric Smelting Furnaces. (Elektrische Schmelzöfen.) C. Häussermann. A general descriptive article of the various forms of electric furnaces which have been used up to the present time. 3000 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20422 D.

Exhibition.

Events at the Electrical Exhibition. An account of the exhibition at Madison Sq. Garden, New York, with illustrated description of many of the exhibits. 9500 w. Elec Eng, N. Y.—May 12, 1898. No. 20173.

Opening of the Electrical Exhibition. An account of the opening, the features of interest and exhibits, giving floor plan. 2100 w. Elec, N. Y.—May 4, 1898. No. 20043.

The Second New York Electrical Exhibition. Editorial review of this exhibition, considering it very creditable. 900 w. Eng News—May 12, 1898. No. 20158.

Frictional Electricity.

The Mechanics of Frictional Electricity. (Die Mechanik der Reibungselektricität.) J. F. Weyde. An endeavor to indicate mechanically the molecular action which occurs in the generation of frictional electricity. 2000 w. Elektrotech Zeitschr—April 28, 1898. No. 20454 B.

Ireland.

Electric Development in Ireland. Brief review of the progress being made in tramways and lighting, with particulars of some of the larger projects. 1700 w. Prac Eng—May 13, 1898. No. 20333 A.

Iron Loss.

The Conditions of Iron Losses in Electric Machines. (Der Zusätzliche Eisenverlust in Elektrischen Maschinen.) G. Dettmar. A description of tests on a rotary converter to determine the losses caused by the armature current. The results are discussed mathematically, and curves plotted. 4000 w. Elektrotech Zeitschr—April 21, 1898. No. 20450 B.

Magnetism.

Meteoric Magnetism. J. Warren. An explanation of the periodic fall of meteoric stones, and tending to show that the planetary universe is the center of an enormous magnetic field. 1800 w. Elec, Lond—May, 1898. No. 20226 A.

On the Susceptibility of Diamagnetic and Weakly Magnetic Substances. Albert P. Wills. Describes a method for the determination of the susceptibility of bodies in which it is extremely small, and giving the actual results obtained from experiments upon a number of substances. 3700 w. Phys Rev—April, 1898. No. 20307 D.

Magnets.

On the Properties of Seasoned Magnets Made of Self-Hardening Steel. B. O. Peirce. Records experiments made, and conclusions drawn, and states the disadvantages of self-hardening steel. 1800 w. Am Jour of Sci—May, 1898. No. 20034 D.

Permeability.

A Magnetic Balance for Workshop Tests of Permeability. J. A. Ewing. Read before the Inst. of Elec. Engs., London. Describes an instrument the use of which requires no knowledge of electrical testing, and which gives useful information in an easy way. 1800 w. Elec, N. Y.—May 25, 1898. No. 20398.

Purdue University.

Electrical Engineering at Purdue University. Illustrated description of the building and its equipment for the instruction of students, describing the electrical laboratory in detail. 2800 w. Elec Wld—May 28, 1898. No. 20381.

Radiography.

Adjustible X-Ray Tubes. A. A. C. Swinton. Read before the Rontg n Soc., London. Part first begins the study of the design of the Crookes tube, investigating the action of the focus tube, aiming at improvement in design. 2500 w. Elec Eng, N. Y.—May 12, 1898. Serial. 1st part. No. 20172.

A Résumé of the Experiments Dealing with the Properties of Becqueral Rays. Oscar M. Sewart. A summary of the present state of knowledge of the subject, with its bearing on the subject of X rays. 5000 w. Phys Rev—April, 1898. No. 20308 D.

On the Cathode-Ray Spectrum. M. Birkeland. From the *Comptes Rendus*. Describes results obtained in recent experiments. 1200 w. Elect'n, Lond—May 13,1898. No. 20343 A.

Radiography and Radioscopy. (Radiographie et Radioscopie.) E. Wallon. A review of the present status and most recent developments in connection with radiography and allied subjects. Serial. 1st part. 3000 w. Le Génié Civil—May 7, 1898. No. 20408 D.

What Are the X-rays? John Trowbridge. Believes the rays to be a manifestation of an electrical disturbance in space. Describes experiments and investigations, and shows the importance of the subject to physical science. Ill. 2300 w. Century Mag—May, 1898. No. 19945 D.

Report.

General Electric's Sixth Annual Report. Full report of the company, showing the earnings for the year to be less than those of last year. 6500 w. Elec, N. Y.—May 4, 1898. No. 20044.

Spain.

Electric Installations in Spain. (Elektrische Anlagen in Spainen.) A. Liètke. A descriptive review of the existing electric plants in Spain, with especial reference to the market for German electrical apparatus. 2500 w. Elektrotech Zeitschr—May 5, 1898. No. 20455 B.

Thermo-Electricity.

The Thermo-Electric Electromotive Force of Crystallized Bismuth. (Sur les Forces Electromotrices Thermo-Electriques dans le Bismuth Cristallisé.) A paper by M. Louis Perrot, showing the influence of the relation of the direction of the current to the plane of cleavage, with valuable data in connection with the generation of thermo-electricity. 1800 w. Comptes Rendus—April 25, 1898. No. 20416 D.

Transformer Efficiency.

A Short Method of Determining Transformer Efficiency. S. E. Johannesen. Compares the shorter with the general method, illustrating its advantage. 250 w. Elec Wld—May 14, 1898. No. 20182.

MARINE ENGINEERING.

BOILERS AND ENGINES.

Dockyard.

The Nagasaki Dockyard. Information concerning the dockyard and slips of the Mitsu Bishi Co., of Japan, and of Hitachi-Maru iron steamship now building. 1100 w. Engr, Lond—April 22, 1898. No. 20023 A.

Friction.

Horse-Power Absorbed by Skin Friction and Wave-Making in Ships of Different Forms and Proportions Deduced from Progressive Trials. James Hamilton. Read before the Inst. of Naval Archts, England. Statement of results deduced from trials of actual vessels showing the principles governing wave-making resistance. 2000 w. Engng—May 13, 1898. No. 20356 A.

Marine Lighting.

Naval Marine Electric Lighting. E. W. Countiss. Description of a war-ship electrical plant, method of installing, illustrations of fittings, fixtures, &c. 1500 w. Am Elect'n—May, 1898. No. 19971.

Marine Progress.

Industry as a Promoter of Marine Technology. (Die Industrie als Förderin der Marine technik.) An address by Herr Von Janke showing the relation between general industrial progress and the development of shipbuilding, with especial reference to the marine progress of Germany. 10000 w. Stahl und Eisen—May 1, 1898. No. 20443 D.

Net Register.

Minimum Net Register and Its Effect on Design. A. G. Ramage. Read at the meeting of the Inst. of Naval Arch'ts., England. The result to the general usefulness of the ship of aiming at a low net register. Abstract of discussion. 2500 w. Steamship—May, 1898. No. 20183 A.

Piping.

The Piping of a Modern Steamship. A. B. Willits. Description of the systems of piping necessary to the proper action of the machinery, with suggestions for arranging. 2200 w. Engr, N. Y.—May 2, 1898. No. 20059.

Resistance.

On Resistance to the Motion of Solids in a Fluid. B. Schieldrop. Read before the Inst. of Naval Arch'ts., England. The object of the paper is to point out a method by which it is hoped experimentally to secure information about the actual magnitude and character of the process to which the various parts of the skin of the solid are submitted. 6400 w. Engng—May 6, 1898. No. 20233 A.

Shipping.

A Simple Solution of the Shipping Question. Edward C. Plummer. An explanation of the system with statement of its advantages. 1100 w. N Am Rev—March, 1898. No. 19983 D.

Yacht.

Fastest Steam Yacht in the World. Illustrated description of the "Ellide," said to have attained a speed of forty miles per hour. 1500 w. Engr, N. Y.—May 2, 1898. No. 20058.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Explosions.

A Locomotive Boiler Explosion. Illustration and account of the wreck of locomotive No. 249, of the Chicago and Norwestern Ry., due to the explosion of its boiler, at Madison, Wis. 1000 w. Wis Engr—Jan., 1898. No. 20279 D.

Boiler Explosion at Paterson, N. J. Describes the destruction of a plant of 14 large boilers in the Passaic Rolling Mills. 600 w. Eng Rec—May 7, 1898. No. 20094.

The Boiler Explosion at Paterson, N. J. An illustrated article on this terrible explosion at the works of the Passaic Rolling Mill Company. 700 w. Eng Rec—May 14, 1898. No. 20216.

Boiler Setting.

The Hanging and Setting of the Horizontal Fire-Tube Boiler. Orosco C. Woolson. A criticism of the common method and the remedy. Ill. 4400 w. Am Soc of Mech Engs, No. 782—Jan., 1898. No. 20253 D.

Boiler-Waters.

The Engineering Chemistry of Boiler-Waters. Henry Leffman. A study of the corroding and scale-forming properties of water in determining its suitability for boiler use. Also discussion. 5200 w. Pro of Engs' Club of Phila—April, 1898. No. 20303 D.

Coal Combustion.

The Correct Method of Coal Combustion. W. H. Booth. Discusses the present practice in England, America and Germany, considering favorably the German system of mechanical stoking and presenting its advantages. 2000 w. Am Mach—May 26, 1898. No. 20502.

Evaporation.

Testing the Evaporation of Boilers. H. B. Budgett. From the *Journal of the British Society of Mining Students*. Deals with means of testing the duty a boiler is doing, giving three methods. 2300 w. Col Guard—May 13, 1898. No. 20359 A.

Feed Water.

The Economy from Heating Feed Water by Live Steam. Calls attention to a theory credited to Prof. Unwin relating to the value of feed heating. 5000 w. Eng Rec—April 30, 1898. No. 19953.

Gas Firing.

Producer Gas for Firing Boilers. Presents the advantages of this system of firing for the purpose of raising steam and its certainty of giving smokeless combustion. 2400 w. Prac Eng—May 6, 1898. No. 20243 A.

Heating Surface.

What Is the Heating Surface of a Steam Boiler? Charles Whiting Baker. Demonstrates that the surface exposed to the fire is the real heating surface of a boiler and reviews facts which show the relative heat absorbing power of water and gases. 4200 w. Am Soc of Mech Engs, No. 783—June, 1898. No. 20252 D.

Lagging.

Boiler and Steam Pipe Lagging. A. E. Urging the importance of lagging locomotives, and discussing the method. 1200 w. Am Eng & R R Jour—May, 1898. No. 19988 C.

Pipe Coverings.

The Protection of Steam Heated Surfaces. C. L. Norton. Partial Report of uncompleted investigations to determine the efficiency of several kinds of pipe covering, the fire risk of certain methods of insulation, and the gain in economy, &c. 4400 w. Am Soc of Mech Engs, No. 786—June, 1898. No. 20251 D.

Smoke Prevention.

Competitive Tests of Murphy Stoker and Hawley Down-Draft Furnace at Detroit Water-Works. Tests made to determine the relative efficiency of the two as regards smoke prevention and economy of fuel. 1300 w. Eng Rec—April 30, 1898. No. 19956.

Steam Engine Tests.

Extension of the Standard Uniform Methods of Conducting and Reporting Steam-Engine Tests. Bryan Donkin. Suggestions bearing on this subject. 2000 w. Am Soc of Mech Engs, No. 774—June, 1898. No. 20261 D.

Plea for a Standard Method of Conducting Engine Tests. George H. Barrus. Presents the need of devising a method for making engine tests in general, offering suggestions. 2000 w. Am Soc of Mech Engs, No. 773—June, 1898. No. 20262 D.

Steam Raising.

See Municipal Engineering, Gas Supply.

Superheating.

The Schmidt Superheating System. Translated from "Portefeuille Economique des Machines." Illustrated description. 1300 w. Am Eng & R R Jour—May, 1898. No. 19987 C.

Tubular Boiler.

The Horizontal Tubular Boiler. Some hints on the proper setting of this kind of boiler, with remarks on its construction and its durability and economy. Ill. 1500 w. Locomotive—April, 1898. No. 20218.

COMPRESSED AIR.

Haulage.

Compressed Air Haulage at Buck Mountain Colliery. T. D. Jones. Read at annual meeting of the Assn. Describes the plant and its operation, giving comparative costs. 1500 w. Anth Coal Op. Assn—May, 1898. No. 20041.

Liquefied Air.

Experiments with Liquefied Air. Brief description of the work accomplished by Charles E. Tripler, and of some experiments with the liquid. Ill. 2000 w. Compressed Air—April, 1898. No. 20033.

The Power Value of Liquid Air. Frank Richards. Discusses briefly what use to make of this peculiar product, showing that it is not

at present likely to be of much value for power or for refrigeration. 1000 w. Am Mach—May 28, 1898. No. 20500.

ENGINES AND MOTORS.

Balancing.

Balancing Steam Engines. Editorial on paper of James Whitcher, read before the Manchester Assn. of Engs. explaining principles of construction and means of avoiding vibration. 1000 w. Engr, Lond—April 26, 1898. No. 20124 A.

Bearings.

Journal Bearing Metals. Considers the best means of attaining a solid bearing to give the greatest satisfactory service at the least cost. 1100 w. Ry Mas Mech—May, 1898. No. 20108.

The Treatment and Prevention of Hot-Bearings. F. Bruton. A few suggestions and directions. 800 w. Elec, Lond—April 22, 1898. No. 19976 A.

Crank Angles.

The Effect of Different Arrangements of Crank Angles upon the Economy of Quadruple Expansion Engines. A. L. Mellanby. Read before the North-East Coast Assn. of Engs. and Shipbuilders, at Newcastle-on-Tyne. An account of a series of experiments carried out on the engines at the Durham College of Science. 2000 w. Ind & Ir—April 29, 1898. No. 20131 A.

Crank Shafts.

Computations for Multiple Crank Shafts for Marine Engines. (Berechnung Mehrmals Gekröpfter Kurbelwellen für Schiffsmaschinen.) H. Von Berling. A very comprehensive study of this important subject, with analytical and graphical investigation of stresses and strains, together with examples showing practical applications. 7500 w. Zeitschr d Ver Deutscher Ing—April 30, 1898. No. 25427 D.

Cylinders.

Cylinder Proportions for High-Pressure Steam. Editorial discussion of means of securing the greatest economy of the engine. 1000 w. Loc Engng—May, 1898. No. 19990 C.

Cylinder Ratios. James Andrews. Read before the North East Inst. of Engs. & Shipbuilers, in Sunderland. Aims at the systematic determination of the relative dimensions of the cylinders in multiple-expansion engines. Diagrams. 2300 w. Ind & Ir—April 22, 1898. Serial. 1st part. No. 20019 A.

Gas Engines.

On a Debated Point in the Theory of the Gas Engine. James D. Roots. Considers why the temperature actually produced only equals about 50% of what should be produced, calculated from the heat units supplied, suggesting a solution of this and other points. 2100 w. Engr, Lond—April 29, 1898. No. 20122 A.

The American-Kilmarnock Gas Engine. Illustrated detailed description. 1800 w. R R Gaz—May 20, 1898. No. 20297.

Governors.

The Shaft Governor. R. C. Carpenter. Discusses the forms of shaft governors with an explanation of the theory. Ill. 3800 w. Power—May, 1898. No. 20053.

Lubrication.

Cylinder Lubrication. Considers the points governing the quantity of oil necessary for the perfect lubrication of steam cylinders, and how to get the best results. 3000 w. Power—May, 1898. Serial. 1st part. No. 20054.

Piston Rods.

Note on the Carbon-Contents of Piston-Rods as Affecting Their Endurance under Fatigue. Joseph E. Johnson, Jr. Data showing the superior endurance of high-carbon steel. 1300 w. Am Soc of Mech Engs, No. 776—June, 1898. No. 20259 D.

Pump.

A New Apparatus for the Elevation of Liquids. (Sur un Nouvel Appareil Destiné à l'Elevation des Liquides.) A new form of gyratory or helical pump, of small size and high efficiency. 1000 w. Comptes Rendus—April 12, 1898. No. 20412 D.

Pumping Engine.

See Mining and Metallurgy, Mining.

Water Motor.

A Simple Water Motor. E. J. Prindle. Illustrates and describes a wheel fitted to a fixed wash basin, by which a power amounting to about $\frac{1}{18}$ h. p. was obtained. 1000 w. Ir Age—May 12, 1898. No. 20179.

Water Wheels.

Impulse Water Wheels. J. T. Farmer. From a paper read before the Canadian Soc. of Civil Engs. A record of research concerning the desirable use of the impulse wheel, giving a brief outline of its development. 2200 w. Can Eng—May, 1898. Serial. 1st part. No. 20194.

The Evolution of the American Type of Water Wheel. W. W. Tyler. A review of the history of the American turbine, giving the results of the competitive tests at Philadelphia in 1859 and in 1876, with the improvements that have been developed and much interesting information. Ill. 6000 w. Jour W Soc of Engs—April, 1898. No. 20507 D.

POWER AND TRANSMISSION.

Cone Transmission.

Transmission by Cone Wheels for Automobiles. (Transmission par Cones pour Automobiles.) Max Ringelmann. A variable speed gear, using a friction plate between two pressure cones, especially adapted for speed controller on automobiles. 1000 w. La Revue Technique—April 25, 1898. No. 20401 D.

Electric Driving.

Electrically Driven Machinery. Schuyler S. Wheeler. Report of a lecture delivered at meeting of the New York Electrical Society, in Madison Sq. Garden. Presents the advantages of electric motors. 1300 w. Elec, N. Y.—May 18, 1898. No. 20286.

Hydraulic Power.

The Utilization of Water Power at Val de Travers. (Wasserkraftausnutzung in Val de

Travers.) Describing the manner in which over 5000 h. p. is taken from the Reuse by four successive power plants, before it flows into the Lake of Neuchatel. 1200 w. Zeitschr d Ver Deutscher Ing—April 23, 1898. No. 20425 D.

The Utilization of Water Power in the Alpine Countries for Railway Purposes. (Ueber die Ausnützung der Wasserkräfte in den Alpenländern zum Betriebe von Local- und Gebirgsbahnen.) An address by Adolf Prasch giving a general account of the utilization of Alpine water powers, with data as to cost and performance. 7500 w. Mitt d Ver f d Förd des Local- und Strassenbahnwesens—April, 1898. No. 20466 F.

Motive Powers.

Motive Powers; Past, Present and Future. Discussion by the N. Y. R. R. Club, considering steam motors and cable motors. 8000 w. N Y R R Club—April 21, 1898. No. 20250 D.

Power Gas.

On Commercial Methods of Utilizing Blast-Furnace Gases for Power Production, and Other Possible Effects on the Pig-Iron Industry. B. H. Thwaite. Read before the conference of British Iron Trade Assn. Records the success of the Thwaite-Gardner blast-furnace power-system and its economic results, discussing the great thermal economies that may be effected. 3500 w. Elec Eng, Lond—May 13, 1898. Serial. 1st part. No. 20339 A.

On the Use of Blast-Furnace Gas for Motive Power. Adolphe Greiner. Read before the Iron and Steel Inst., England. A summary of investigations that have been made in this field, with the advantages accruing from the use of gas. 2500 w. Ind & Ir—May 13, 1898. No. 20347 A.

The Direct Application of Blast-Furnace Gases for Power Generation. (Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung.) An account of the practical success of the installation at the Cockerill Work at Seraing, and the report of Prof. Hubert thereon. 3000 w. Stahl und Eisen—April 15, 1898. No. 20441 D.

The Utilization of Blast-Furnace Gases. Abstract of paper by Dr. F. Luehrmann, read at meeting of German Iron Masters' Union. The paper stated all the objections to the use of gas engines in a blast-furnace plant, but the discussion regarded the subject more hopefully. 1200 w. Eng & Min Jour—April 30, 1898. No. 19963.

The Utilization of Blast-Furnace Gases for Electrical Power Transmission. W. H. Booth. Analyzes the amount of heat contained in waste gases and gives calculations for the horse-power of a blast furnace. 1300 w. Elec Rev, Lond—April 22, 1898. Serial. 1st part. No. 20005 A.

The Utilization of Blast-Furnace Gas for the Production of Power. W. H. Booth. A very complete discussion, showing the theoretical value of blast-furnace gases for use in gas engines, and also an account of the successful practical application and tests at Wishaw, near Glasgow. 3500 w. Engineering Magazine—June, 1898. No. 20476 B.

The Utilization of Blast-Furnace Gas in Gas Engines at the Cockerill Company's Works. Translated abstract from an article by Prof. Hubert in the *Annales des Mines de Belgique.* Illustrates the arrangement in use, and explains the system briefly. 1000 w. Ir & Coal Trds Rev—April 29, 1898. No. 20127 A.

Power Plants.

The Comparative Advantages of Steam and Water Power. Discussion of the relative economy, and giving illustrations showing that every case must be determined on its merits, as these vary widely. 3000 w. Can Elec News—May, 1898. No. 20083.

Pulleys.

The Designing of Cone Pulleys. Walter K. Palmer. Discussion of the problem, with the deduction of a practical method. 8800 w. Kansas Univ Quar—April, 1898. No. 20223 D.

Steam Engines.

Armington and Sims New Slow Speed Engine. Illustrates general design and details of new form of inertia governor and releasing gear with steam dash-pot. 600 w. Eng Rec—April 30, 1898. No. 19958.

Steam Turbine.

The Steam Turbine Engine and Its Applications. Jno. D. Bailie. Abstract of a paper read before the Yorkshire College Engng. Soc. Describes the leading features of the "Twin Parallel Flow" and the "Radial Flow" turbines, the modern type, and the Steam Turbo-Dynamo. 3200 w. Elec Rev, Lond—May 6, 1898. No. 20245 A.

SHOP AND FOUNDRY.

Appliances.

Foundry Appliances. S. H. Stupakoff. Read before the Pittsburg Foundrymen's Assn. Discusses the equipment of the modern foundry, indicating directions where improvements may be made, possible economies, &c. 3700 w. Ir Trd Rev—May 26, 1898. No. 20515.

Bearings.

The Micro-Structure of Bearing Metal. Quotes conclusions of Dr. Dudley, chemist of the Pennsylvania R. R., and the results of personal study. 1000 w. R R Gaz—May 13, 1898. No. 20195.

Brass.

Brass-Melting Furnaces. Joseph Horner. Part first deals with the mixing metal, and methods of making brass. 2500 w. Mech Wld—April 22, 1898. Serial. 1st part. No. 19972 A.

Couplings.

The Relations between Forces and Stresses in Wedge Couplings. (Kraft- und Spannungsverhältnisse in Schubkeilkupplungen.) H. Bethmann. An analysis of that form of friction coupling in which a cut ring is expanded by a wedge. 1800 w. Zeitschr d Ver Deutscher Ing—May 7, 1898. No. 20429 D.

Crane.

100 Ton Derrick Crane. (Derrik-Kran von 100,000 kg. Tragfähigkeit.) Illustrated description of the powerful new wharf crane recently erected at the shipyards of Blohm & Voss, at

Hamburg. 1800 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20421 D.

See Electrical Engineering, Power.

Cupola Cinder.

The Recovery of Iron from Cupola Cinder. W. J. Keep. Presented at convention of the Nat. Assn. of Stove Mfrs. at Phila. Gives facts concerning the prevention of this waste, and the saving effected. 1600 w. Met Work—May 28, 1898. No. 20525.

Deterioration.

Fatigue and Deterioration of Metals. Walter A. Zinn. An explanation of the cause, with discussion of whether steel or iron is better for railway car axles. 2400 w. Wis Engr—Jan., 1898. No. 20278 D.

Dies.

Relation of the Machinist's Trade to Die Making. George B. Painter. Presents some of the disadvantages due to the modern practice of dividing the work into sub-branches, and the limited knowledge of metal working. 1400 w. Am Mach—May 26, 1898. No. 20501.

Files.

Making Files. From *Modern Machinery*. Describes the making of files, and the difficulties met in endeavoring to have the work done mechanically, and the device which has proved successful. 2400 w. Bos Jour of Com—May 14, 1898. No. 20221.

Forgings.

Steel Forgings for Pumping Engines. H. F. J. Porter. Reviews briefly the history of the development of forging in the United States, and the processes which are considered the best practice for making steel forgings, the causes of defects, and the direction in which improvements are tending. Ill. 5000 w. Sib Jour of Engng —May, 1898. No. 20377 C.

Shop Costs.

Effective Systems of Finding and Keeping Shop Costs. Henry Roland. Describing the methods in use at the extensive machine tool works of Bement, Miles & Co., Philadelphia, with blank forms and details of daily application. 3000 w. Engineering Magazine—June, 1898. No. 20474 B.

Springs.

Steel Springs for Motor Cars. Excerpt of a paper read before the Liverpool Centre of the Self-propelled Traffic Assn., by J. Bedford. Gives an outline of the method of making bars suitable for making all kinds of springs, with analysis of acid steels used for laminated springs. with list of springs and their leading particulars, 1000 w. Prac Eng—May 6, 1898. No. 20242 A.

The Theory of Springs. (Theorie der Federn.) Prof. Kirsch. An elaborate mathematical treatment of plate, helical and spiral springs, with diagrams for aid in performing computations. 5000 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20420 D.

What a Machine Designer Should Know About Springs. J. Begtrup. Presents the principles upon which their action depends in a form that may be easily understood. Ill. 3500 w. Mach, N. Y—May, 1898. Serial. 1st part. No. 20049.

Stay-Bolts.

Bending Tests of Locomotive Stay-Bolts. Francis J. Cole. Illustrates the machine used for testing, discussing the results, giving photographs of test specimens and information concerning cost. 1500 w. Am Soc of Mech Engs, No. 775—June, 1898. No. 20260 D.

Tanks.

Making Tank Plates. Joseph Horner. Illustrated description of English practice. 1800 w. Am Mach—May 12, 1898. Serial. 1st part. No. 20165.

Tools.

Accurate Screw Machine Work Turning Tools. J. O. Surface. Hints on the making and use of tools. Ill. 1200 w. Am Mach—May 19, 1898. No. 20283.

Notes on the Driving of Machine Tools. (Zur Keuntnis der für Werkzeugmaschinen Gebräuchlichen Wendegetriebe.) H. Fischer. Especially devoted to improved driving and reversing gear for planers, with reference to increased cutting speeds. 6000 w. Zeitschr d Ver Deutscher Ing —May 7, 1898. No. 20428 D.

MISCELLANY.

Automobiles.

Automobile Vehicles. (Automobile.) L. Czischek. A general review of the subject, with many illustrations and tabulated details of performances. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—April 29, May 6, 1898. No. 20431 each B.

Recent Electric Motor Vehicles for City Streets. Illustrates and describes four types of horseless vehicles which are in daily use, and found to be successful and economical. 1500 w. Eng News.—May 19, 1898. No. 20274.

The Freakley Steam Carriage. Illustrated description of an experimental carriage which has stood severe tests. Its great feature is its flexibility. 2400 w. Engr, Lond—April 22, 1898. No. 20026 A.

Cotton.

One Hundred Years of Ginning and Baling Cotton. George A. Lowry. History of the progress of mechanical invention in this field, giving much information. Ill. 3300 w. Am Soc of Mech Engs, No. 780—June, 1898. No. 20255 D.

Diagrams.

A New Graphical Method of Finding the Areas of Irregular Diagrams. Alfred E. Wiener. Gives a graphical method for measuring irregular planes. 1600 w. Am Mach—May 19, 1898. No. 20282.

Graphic Diagrams and Glyptic Models. R. H. Thurston. Discussing the value of graphic and glyptic methods, giving examples for illustration, showing how readily they permit the solution of important problems and other results of the applications of this system. Ill. 10000 w. Am Soc of Mech Engs, No. 777—June, 1898. No. 20258 D.

Elasticity.

The Equations of the Elastic Theory. Sur les Equations de la Theorie de l'Elasticité.) A communication to the French Academy by MM. Eugène and François Cosserat, giving the fundamental equations of the mathematical theory of elasticity. 1500 w. Comptes Rendus—April 12, 1898. No. 20411 D.

Flow in Pipes.

Experiments on the Flow of Water in the Six-Foot Steel and Wood Pipe Line of the Pioneer Electric Power Company at Ogden, Utah. Charles D. Marx, Charles B. Wing and Leander M. Hoskins. Describes a series of experiments made to determine the relation between the rate of discharge and the loss of head between certain definite points, giving methods adopted and results obtained. Ill. 13800 w. Pro Am Soc of Civ Engs—May, 1898. No. 20394 F.

Hydraulic Pressures.

Experiments with Water under High Pressures. Their object was to determine the permeability of steel plates and the friction in steel pipes under heavy pressures. 600 w. Eng Rec —April 30, 1898. No. 19957.

Mechanical Plants.

See Architecture and Building, Construction.

Patents.

Patents. James W. See. Deals with questions on which inventive mechanics and manufacturers should be posted. 10300 w. Am Soc of Mech Engs, No. 779—June, 1898. No. 20256 D.

Pumps.

The Pump and Its Principle. Describes and illustrates the construction and mode of action of the common suction pump. 1800 w. Ill Car & Build—May 6, 1898. No. 20228 A.

Refrigeration.

Refrigerating Machinery. Howard Lee Davis. Describes the process of refrigeration, and plant, mentioning some of the peculiarities of ammonia. 2000 w. Yale Sci M—April, 1898. No. 20036 D.

Resistance.

A Study of Bach's Law $\varepsilon = a\sigma^m$. (Studie über das Bachsche Gesetz $\varepsilon = a\sigma^m$.) L. Geusen. A mathematical discussion of the law of Bach expressing the relation between extension and stress, with applications to practical examples. 3500 w. Zeitschr d Ver Deutscher Ing—April 23, 1898. No. 20424 D.

The Resistance of Thick Masses. (Sur la Résistance des Massifs Epais.) A note to the French Academy by M. Ribière, discussing the diminution of resistance to pressure in the interior of thick masses of material. 1200 w. Comptes Rendus—April 25, 1898. No. 20414 D.

Sand Blast.

See Mining and Metallurgy, Mining.

Skates.

The Manufacture of Skates. (Die Herstellung der Schlittschuhe.) An illustrated description of the methods of manufacturing skates of various kinds, with details of processes and special machines. 2500 w. Stahl und Eisen—May 1, 1898. No. 20444 D.

Stage Mechanism.

Stage Mechanism. Edwin O. Sachs. Showing how modern sciences and methods have been applied in stage management. Ill. 5500 w. Jour Soc of Arts—April 22, 1898. No. 19975 A.

Stevens.

A Family of Engineers. T. C. Martin. An account of the great work of John Stevens and his sons. Ill. 4500 w. Cos—May, 1898. No. 20097.

Testing Materials.

Difficulties Encountered in Testing Cast Iron. P. Kreuzpointner. Read before the Pittsburg Foundrymen's Assn. Considers the question of solution and segregation affecting the physical qualities of cast iron, and difficulties because of the composition of its elements. 3200 w. Ir Trd Rev—April 28, 1898. No. 19951.

Experiments in Cast Iron Cylinders. C. H. Benjamin. Results of a series of experiments made to determine the bursting strength of cast iron cylinders under water pressure. Ill. 3300 w. Am Soc of Mech Engs, No. 778—June, 1898. No. 20257 D.

The Behavior of Wrought Iron Cylinders under Compression. W. Kendrick Hatt. Presents the results of a series of tests made at Purdue University, to determine the influence of the shape of the specimen on its ultimate strength, and other information. 1200 w. Eng News—May 12, 1898. No. 20159.

The Relative Strength of Wrought Iron and Steel Pipe. Report of tests made by Henry M. Howe, at the instance of the National Tube Works Co., the results showing a very great superiority of the steel pipe over the wrought iron. 1000 w. Am Mfr & Ir Wld—April 29, 1898. No. 19989.

Tubing.

Method of Manufacture and Tests of a New Seamless Tube. R. C. Carpenter and P. J. Fickinger. Describes a new form of tubing made by drawing lap welded steel tubing until the desired gauge is obtained. The process is fully described, and the high quality of the product shown by the results of tests. 2500 w. Am Soc of Mech Engrs, No. 785—June, 1898. No. 20469 D.

Water Conductors.

Experiences in Planning and Constructing Water Conductors. (Erfahrungen bei Projectirung und Betrieb von Wasserleitungen.) H. Adolf. Giving some points in connection with air trapping and water hammer; also influence of temperature changes. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—April 15, 1898. No. 20431 B.

Zeuner Diagram.

The Zeuner Diagram. William Fox. Aiming to prove that there are no problems incapable of an exact geometrical solution by means of this diagram. 800 w. Jour Fr Inst—May, 1898. Serial. 1st part. No. 19948 D.

MILITARY ENGINEERING.

Armaments.

The Growth of the World's Armaments. H. W. Wilson. An examination of the position of the great nations of Europe, based on statistics of the last thirty years. Diagrams. 1800 w. Nineteenth Cent—May, 1898. No. 20199 D.

Armor.

Armor Clads. Osborne Atwater Day. Historical account of the use of armor for the protection of vessels. 1300 w. Yale Sci M—April, 1898. No. 20037 C.

The United States Authorities and Krupp Process Armor. An important paper submitted to the U. S. Senate Committee on Naval Affairs by Capt. O'Neill, on the relative qualities and efficiency of European and American armor plate for warships, with English comment on the trial. 5000 w. Engr, Lond—April 22, 1898. No. 20024 A.

Armored Ships.

The First Battle Between Armored Ships. Accounts of the battle between the Merrimac and Monitor, and its effect on naval ship building. 5000 w. Loc Firemen's Mag—May, 1898. No. 19984.

Arsenal Equipment.

The Electrical Equipment of the Watervliet Arsenal. Brief account of the plant for supplying light and power for these mammoth gunshops of the United States. Ill. 1000 w. Elec Wld—May 7, 1898. No. 20062.

Auxiliary Vessels.

List of Vessels Recently Purchased or Requisitioned by the Navy. Reference table giving the new name of each vessel with her general characteristics. 1500 w. Marine Engng—May, 1898. No. 20114 C.

Battleships.

Launch of the United States Battleships Kearsarge and Kentucky. Illustrated description of these vessels with principal data of the launch. 3300 w. Marine Engng—May, 1898. No. 20112 C.

The Spanish Battleship "Pelayo." A brief description of the new boiler installation with leading particulars and dimensions. 1100 w. Engng—April 22, 1898. No, 20017 A.

The Trial of the Battleship. Park Benjamin, in the *Independent*. Comments on the complexity of the mechanical structure and increased liability to injury. 800 w. Am Mach—May 12, 1898. No. 20166.

Coal.

Coal in Modern War. From the St. Louis *Globe Democrat*. Some of the reasons why coal is a tremendous factor in modern naval operations. 1500 w. Bos Jour of Com—May 21, 1898. No. 20322.

Cruisers.

Spain's Armored Cruisers. Gives data with regard to these vessels and compares the American vessels Ill. 1100 w. Engr, Lond—April 29, 1898. No. 20123 A.

The United States Protected Cruiser "Olympia." Brief review of this flagship of the Asiatic fleet, whose battle with a Spanish squadron in Manila Bay is now a topic of interest. Ill. 4500 w. Eng News—May 5, 1898. No. 20076.

Defense.

Maritime Construction and National Defense. (Les Constructions Maritimes et la Défense Nationale.) Calling attention to the weak points in the maritime defense of France and urging the encouragement of French establishments for the construction of marine work. 1200 w. Moniteur Industriel—April 30, 1898. No. 20462 G.

Explosives.

Modern High Explosives. A topical discussion in which their nature and mode of action was considered by Louis Y. Schermerhorn, and their application in warfare by Arthur Falkenau; a general discussion following. Ill. 6000 w. Pro of Engs' Club of Phila—April, 1898. No. 20302 D.

Guns.

Mechanical Operations in the Manufacture of a Great Naval Gun. Edwin J. Prindle. A richly illustrated article describing the work at the Washington Gun Factory, with especial reference to the construction of the 13-inch naval guns used on the U. S. battle ships. 4000 w. Engineering Magazine—June, 1898. No. 20472 B.

Holland Boat.

Electricity in the Submarine Boat "Holland." R. McA. Lloyd. A brief description of the electrical apparatus. Ill. 1000 w. Elec Eng, N. Y.—May 12, 1898. No. 20170.

"Maine."

The Destruction of the "Maine." Editorial on the report of the court of inquiry concerning this disaster, and advancing a possible hypothesis to account for the upward bend in the bottom as reported. 2300 w. Engng—April 22, 1898. No. 20015 A.

The "Maine" Disaster. Editorial holding the opinion that the explosion was outside the vessel on the port side. 800 w. Ind & Ir—April 22, 1898. No. 20020 A.

Manila.

The Great Naval Victory at Manila. Discussion of the opposing forces, giving the composition of both American and Spanish squadrons, and some information of the harbor fortifications. Map. 1800 w. Sci Am—May 14, 1898. No. 20164.

Position Finder.

An Apparatus for Pointing by Means of an Elevated Line of Metal Automatically Finding Concealed Position. Froissart. An illustrated outline of apparatus, stating the object sought and the results obtained. 7500 w. Jour U. S. Artillery—March-April, 1898. No. 20198 D.

Range-Finders.

Concerning the Reliability of Range-Finding

Shots. Rohne. An investigation showing the uncertainty of correct fork construction, and how the range can be made more reliable. 10000 w. Jour U. S. Artillery—March-April, 1898. No. 20197 D.

Rapid-Fire Guns.

The Rapid-Fire Guns of the New Orleans. Illustrated description of the guns and their operation. 1500 w. Sci Am—May 21, 1898. No. 20284.

Spanish Navy.

Strength of the Spanish Navy Brought Down to Date. Gives a series of reference tables, with remarks. 2000 w. Marine Engng—May, 1898. No. 20113 C.

Squadrons.

English Engineer's Analysis of Squadrons of Spain and United States, with a Reply. Gives a comparison published in the London *Engineer*, and a criticism of it. Ill. 2500 w. Sci Am—May 7, 1898. No. 20048.

Torpedo Boat.

An Electric Torpedo Boat. Advantages that would result from the displacement of the steam engine by a primary battery for this kind of vessel. 1500 w. Elec Wld—May 21, 1898. No. 20269.

Compressed Air on the Holland Torpedo Boat. G. Wilfred Pearce. Reviews the previous attempts at submarine boat construction, describes the Holland boat, and the various applications of compressed air. Ill. 1800 w. Compressed Air—April, 1898. No. 20032.

Submarine Torpedo-Boats. William H. Jaques. Read before the Inst. of Naval Arch'ts. Refers to the defects in torpedo-boats made evident in the China-Japan war, and emphasizes the fact that submarine navigation is now an accomplished fact, discussing the influence it will have on torpedo-boat architecture and naval warfare. Ill. 4400 w. Engng—April 29, 1898. No. 20142 A.

War Material.

Illustrations of Machine Shop Work on War Material. Many illustrations with brief notes. Describes the Buffington-Crozier disappearing gun carriage, breech-loading rifled mortars, &c. 1800 w. Am Mach—May 5, 1898. No. 20203.

MINING AND METALLURGY.

COAL AND COKE.

Chemistry of Coal.

The Chemistry of the Coals of the Clyde Basin. W. Carrick Anderson. Summary of paper read before the Philosophical Society of Glasgow, written in competition for the Graham Gold Medal. Investigations with a view to finding out points of difference in character and reaction between non-coking and true coking varieties. 5500 w. Col Guard—April 22, 1898. No. 20021 A.

Coal Cutting.

Coal-Cutting Machinery. Cyrus Robinson. Considers its present efficiency and how it may be increased by a combination of electricity and compressed air. 1200 w. Mines & Min—May, 1898. No. 20067 C.

Coal Industry.

The Coal Industry of the Rhenish Westphalian Provinces. T. R. Mulvany. From the British Consular Repts. Shows the benefits from a combination of a number of collieries, thus doing way with reckless competition, and reports the conditions in detail. 3300 w. Ir & Coal Trds Rev—April 29, 1898. No. 20129 A.

Coke.

The Breaking and Classifying of Coke. M. Hoyer. Translated from *Le Gaz*. Read before the Société Technique Belge de l'Industrie du Gaz, as a continuation of a similar paper read in 1896. Describes a new coke breaker, giving results obtained during a year's operation. 800 w. Pro Age—May 2, 1898. No. 20057.

Coking.

On Coking in By-Product Ovens. John H. Darby. Read before the Iron & Steel Inst., London. The manufacture of coke, with special attention to the recovery of by-products. Many points of practice in the working of the Semet-Solvay oven are noticed. 2500 w. Ind & Ir—May 13, 1898. No. 20349 A.

Fuel Testing.

The Chemical Analysis and Testing of Fuel. L. Campredon. From *Annales de Chimie Analyt.* Explains the usefulness of analysis and testing in determining their suitability for the purposes intended, and defines chemical and ultimate analysis, describing special tests. 2500 w. Col Guard—April 29, 1898. No. 20135 A.

Germany.

By-Product Coke-Making in Germany. From a British Consular Report by T. R. Mulvany. Stating the advantages of coke-ovens with the recovery of by-products, the decrease in the number of round ovens and increase in by-product ovens, with particulars relating to the system used. 1200 w. Col Guard—April 29, 1898. No. 20136 A.

Coke Ovens and By-Products in Germany. Abstract from a Foreign Office Report by Kurt Seebohm. Reports the abandoning of the old round coke ovens and describes the systems adopted in the new by-product ovens. 1600 w. Ir & Coal Trds Rev—April 29, 1898. No. 20128 A.

Haulage.

See Mechanical Engineering, Compressed Air.

Indiana Coal.

Mining Indiana Coal. P. J. Mooney. Read before the Indiana Mining Inst. at Terre Haute, Indiana. Discusses the profitable amount to mine from the "L" seams, how to mine it and prevent creeps and squeezes. 1700 w. Mines & Min—May, 1898. No. 20065 C.

Peat.

The Application of North-German Peat n

Electric Power Stations. (Ueber die Verwertung der Norddeutschen Moore Insbesondere für Elektrische Kraftstationen.) A paper by Dr. Frank, showing the value of these deposits of turf, the heating value of which is about one-third that of an equal quantity of coal. 1500 w. Glückauf—April 16, 1898. No. 20447 B.

Production.

The Coal Production of the Principal Countries of the World. Interesting statistics taken from the annual statement by the Board of Trade. 2200 w. Col Guard—April 29, 1898. No. 20-134 A.

COPPER.

California.

Copper Mining in California. H. A. Brainard describes the Copperopolis properties in Calaveras Co., and reports of deposits in other parts of the state are given. 1500 w. Min & Sci Pr—May 21, 1898. No. 20513.

Deposits.

The Copper Deposits Omaunu No. 2, Whangaroa County, N. Z. Report of an examination made by the government geologist. 1200 w. N Z Mines Rec—March 16, 1898. No. 20-372 B.

GOLD AND SILVER.

Alaska.

Distribution of Gold in Alaska. R. H. Stretch. Presents views based on work extending over a period of three months. 1400 w. Min Ind & Rev—May 5, 1898. No. 20086.

The Alaskan Gold Fields and the Opportunities They Offer for Capital and Labor. Samuel C. Dunham. Report of official investigations made under government instructions, giving information of value on all subjects relating to this region. Ills. and maps. 7200 w. Bul of Dept of Labor—May, 1898. No. 20503 D.

Alluvial Mining.

Revival in Victorian Alluvial Mining. William Bradford. Information concerning the plains south of Ballarat. Ill. 1700 w. Aust Min Stand—April 7, 1898. Serial. 1st part. No. 20120 B.

Assay.

The Scorification Assay. John Daniell. Notes from the writer's experience in the estimation of gold and silver by this process. 1300 w. Jour of Chem & Met Soc of S Africa—March, 1898. No. 20078 E.

Colombia, S. A.

An Outline of the Gold Fields in Colombia, South America. Francis C. Nicholas. Statements based on extensive explorations of the country giving a general outline of certain conditions relating to the mines of this region. 2500 w. Eng & Min Jour—April 30, 1898. No. 19962.

Colorado.

Cyanid, Chlorination and Amalgamation in Colorado. R. B. Turner. Condensed from report of State Bureau of Mines. Information of the treatment of ores by these processes at Cripple Creek and various other points, with the cost and manner of applying. 3000 w. Min & Sci Pr—May 21, 1898. No. 20514.

Concentration.

Concentration Plants for Small Mines. F. L. Bartlett. Presents the advantages of concentration and describes some simple and cheap plants, urging less costly and complicated mills. Ill. 3000 w. Eng & Min Jour—May 7, 1898. No. 20109.

Cyanid.

The Largest Cyanid Gold Reduction Works in the World, W. P. Hardesty. An interesting account of the Golden Gate Mill of the De La Mar's Mercur Mines Co., Mercur, Utah. Ill. 3500 w. Eng News—May 19, 1898. No. 20-272.

Deep Leads.

The Deep Leads of Victoria. E. Lidgey, Giving account of the mining in Victoria, showing how the miner has been gradually sinking deeper shafts, and the great promise of the deep leads. 3500 w. Aust Min Stand—April 21, 1898. Serial. 1st part. No. 20380 B.

Dredging.

Dredging the N. S. W. Rivers. A. O. S. M. Suggests the advisability of testing the rivers known to contain auriferous gravel, and gives a brief history of this industry in New Zealand. Ill. 1300 w. Aus Min Stand—March 17, 1898. No. 20050 B.

Yukon Dredging. R. H. Stretch. Considers it exceedingly questionable whether such operations in Alaska would meet with success, and gives reasons for the opinion. 1200 w. Min Ind & Rev—May 19, 1898. No. 20360.

Gold Bearing Sands.

Notes on the Auriferous Iron-Sands of New Zealand. Alexander McKay. Describes these deposits, and the manner of working the beaches. 1200 w. N Z Mines Rec—April 16, 1898. No. 20373 B.

Klondike.

The Gold Region of the Klondike. Describes a new route to be opened by the Canadian government which will remove the great difficulties of transport to the Yukon district. Also briefly comments on the mistake of people going who were physically and intellectually unable to cope with the conditions existing. 900 w. Bd of Trd Jour—May, 1898. No. 20390 A.

Milling.

Milling and the Cyanid Process. Arthur Lakes. Kinds of ores to which the different processes are applicable are discussed. 1500 w. Mines & Min—May, 1898. No. 20069 C.

Mount Lyell.

Mount Lyell Up to Date. Describes the locality, conditions and surroundings of this mine in Tasmania. 3300 w. Aust Min Stand—March 17, 1898. No. 20051 B.

New South Wales.

The Minerals and Metals of New South Wales. Perry F. Nursey. Calling attention to points of interest in the report of T. A Cogh-

lan, government statistician. 1800 w. Ind & Ir—April 19, 1898. No. 20130 A.

New Zealand.

The Mining Industry of New Zealand. Perry F. Nursey. Gold mining is the predominating element. Information from the report of A. J. Cadman. 2400 w. Ind & Ir—April 22, 1898. No. 20018 A.

Ore Treatment.

Metallurgical Methods in Use at Broken Hill. G. H. Blakemore. History of the methods in vogue in this Australian mine, dealing with smelting, lixiviation and choloridizing, amalgamation and concentration. 2800 w. Aust Min Stand—March 31, 1898. Serial. 1st part. No. 20379 B.

Production.

United States Gold and Silver Production in 1897. Detailed statement comparing the figures with the two previous years. 2500 w. Eng & Min Jour—May 14, 1898. No. 20191.

Siberia.

The Siberian Railway and the Siberian Gold Districts. (Die Sibirèsche Eisenbahn und die Gold-vorkommen Sibiriens.) A discussion of the probable effects of the access by railway upon the gold regions of Siberia, with data as to locations and past output. 2000 w. Glückauf—April 30, 1898. No. 20448 B.

Tailings.

Successful Treatment of Tailings by the Direct-Filling Process. F. Cardell Pengilly. A short description of the plant and method of treatment by this process as carried on at the mines of the New Kleinfontein Co. (Limited), in the Witwatersrand goldfield, which has given good results. 1200 w. N Z Mines Rec—April 16, 1898. No. 20374 B.

Witwatersrand.

Milling the Gold Ores of the Witwatersrand. H. H. Webb, Pope Yeatman. A fully illustrated description of the mills of the various mining companies, showing the stamps, vanners, sorting belts, etc., with details of milling operations as conducted on the Rand. 4500 w. Engineering Magazine—June, 1898. No. 20475 B.

IRON AND STEEL.

Bilbao.

Past and Present at Bilbao. (Altes und Neues über Bilbao.) A. Kaysser. A descriptive sketch of former and modern methods of handling iron ore at the Spanish port. 3000 w. Stahl und Eisen—April 15, 1898. No. 20442 D.

Blast Furnaces.

On the Relative Merits of Limestone and Lime in Blast-Furnace Practice. Charles Cochrane. Read before the Iron and Steel Inst., England. Presents the results of a comparison of limestone and lime employed as flux at a furnace 90 feet high and about 34,500 cubic feet capacity, at Ormesby Ironworks, Middlesborough. 3000 w. Ind & Ir—May 13, 1898. Serial. 1st part. No. 20348 A.

Carbon.

The Moist Combustion Methods of Determining Carbon in Steel. George Auchy. Presented to the Am. Chem. Soc. Showing that this process may work faultily in particulars mentioned. 1500 w. Ind & Ir—April 29, 1898. Serial. 1st part. No. 20132 A.

Furnaces.

Re-Heating Furnaces for Iron and Steel. Fred. Mills. Considers some of the re-heating furnaces in the districts of the West of Scotland and the Northeast Coast. Ill. 2200 w. Ir & Coal Trds Rev—April 22, 1898. No. 20004 A.

India.

The Iron Resources of India. Editorial on the report of Jeremiah Head, quoting some facts. 2500 w. Engng—May 6, 1898. No. 20231 A.

Metal Working.

Effects of Heating and Working on Iron and Steel. H. E. Smith. Treats of the effects of working and heat treatment which result in bringing out the highest qualities of the iron or steel, or which unfit the metal for the use intended. 3700 w. Jour Assn of Engng Soc's—March, 1898. No. 19979 C.

Pig Iron.

How to Secure Uniformity in Pig Iron Analysis. Extracts from letters drawn out by paper of Thomas D. West before the Pittsburg Foundrymen's Assn. 2800 w. Ir Trd Rev—May 5, 1898. No. 20118.

How to Secure Uniformity in Pig Iron Analysis. Further extracts from letters called out by paper of Thomas D. West before the Pittsburg Foundrymen's Assn. 1800 w. Ir Trd Rev—May 12, 1898. No. 20184.

Silicon.

The Conditions in Which Silicon and Chromium are found in Siderurgical Products. (Recherches sur l'Etat où se Trouvent le Silicium et le Chrome dans les Produits Sidérurgiques.) MM. Carnot and Goutal. An examination of the manner in which silicon and chromium are combined with iron and carbon as a result of smelting operations. 2500 w. Comptes Rendus—May 2, 1898. No. 20418 D.

Statistics.

Some Graphic Statistics. George R. Bale. Diagrams showing production of iron and steel of various countries in 25 years, with the present position, are given in part first. 700 w. Prac Eng—April 29, 1898. Serial. 1st part. No. 20125 A.

Structure.

The Crystalline Structure of Iron and Steel. John E. Stead. A résumé of the more practical points of a paper presented at the meeting of the Iron and Steel Inst., London. 3000 w. Ir & St Trds Jour—May 14, 1898. No. 20332 A.

Tin-Plate.

The Position and Prospects of the Tin-Plate Industry. John Jenkins. A paper read at meeting of the British Iron Trade Assn. Gives figures showing total production, exports, etc., comparing them with the United States reports, with discussion of cost, and points relating to transportation, etc. Also discussion. 2000 w. Col Guard—May 6, 1898. No. 20237 A.

MINING.

Coal Dust.

The Coal Dust Danger, and Methods of Combating it. (Die Kohlenstaubgefahr und ihre Bekämpfung.) An address by Director Behrens upon the dangers of coal dust explosions in mines, with especial reference to the method of preventing them by sprinklers. Two articles. 6000 w. Glückauf—April 16, 30, 1898. No. 20446 each B.

Electric Mining.

Central-Station Electric Coal-Mining Plant in Pennsylvania, U. S. A. William Stukely Gresley. Paper giving an illustrated description of the plant and its operation, with an abstract of the discussion. 16500 w. Pamphlet. Published by Inst. of Civil Engs., London. No. 20399 G.

Electrical Appliances in Colorado Mines. Thomas Tonge in London *Mining Journal*. Calls attention to the readily available power to be found in the mountain streams, and mentions a few of the leading instances where this power has been utilized for electrical purposes. 1200 w. N Z Mines Rec—April 16, 1898. No. 20375 B.

The Applications of Electricity in Mining Operations. Roslyn Holiday. From the *Journal of the British Society of Mining Students*. Deals with application of electricity to lighting, hauling, pumping and coal-cutting. 3500 w. Col Guard—May 6, 1898. No. 20239 A.

Fan Curves.

Fan Characteristic Curves. S. Hanappe, in a paper to the Société des Ingéniéurs des Mines du Hainaut. An examination of some of these curves as bearing upon a full sized Guibal fan. 4000 w. Col Guard—May 6, 1898. No. 20236 A.

Firedamp.

Carbonic Oxid, Firedamp, and the Grisoumetre. (L'Oxyde de Carbone, Le Grisou, et le Grisoumètre.) An address delivered by Dr. Gréhant, describing the application of his device called the grisoumètre for determining the proportion of dangerous gases in mine air. 6000 w. Bulletin de la Société d'Encour—April, 1898. No. 20409 G.

Explosives and Firedamp in Belgium. (Les Explosifs et le Grisou en Belgique.) H. Schmerber. A critical review of the investigations made in Belgium as to the effect of various blasting explosives in igniting firedamp. 1500 w. Le Génie Civil—April 23, 1898. No. 20404 D.

Explosives and Firedamp. (Explosifs et le Grisou.) H. Schmerber. A review of the present condition of the subject in the principal mining countries of Europe. 3500 w. Le Génie Civil—April 30, 1898. No. 20406 D.

The Ignition of Firedamp by Electricity. (Entzündbarkeit der Schlagwetter durch Elektrizität.) A review of the experiments of Drs. Heise and Thiem, with a reply by Dr. Heise. 3000 w. Glückauf—May 7, 1898. No. 20449 B.

The Influence of Self-Induction in the Explosion of Mixtures of Fire-damp and Air by the Electric Spark. (Sur l'Influence de la Self-Induction dans l'Explosion des Mélanges de Grisou et d'Air par l'Etincelle Electrique.) A note to the French Academy by MM. Couriot and Meunier, discussing the conditions under which self-induction may become a source of danger. 1500 w. Comptes Rendus—April 18 1898. No. 20413 D.

Mining Motors.

The Design of Mining Motors. F. C. Caldwell. Read before the Ohio Inst. of Min Engs. The principles of their construction and the points to be considered in selecting motors for mining work. Ill. 2200 w. Mines & Min—May, 1898. No. 20066 C.

Pneumatophore.

Employment of the Pneumatophore in Irrespirable Gases. Bergrat Behrens. From a communication to *Glückauf*. Reports experiments made at the Shamrock Colliery in Westphalia, to determine the extent to which the apparatus could be used in an underground fire. The trials show that a certain amount of instruction and practice is required for its use. 2000 w. Col Guard—April 29, 1898. No. 20137 A.

Pumping Engine.

A Triple-Expansion Mine Pumping Engine. Illustrated description of a mine pumping engine for the New Jersey Zinc Co., showing some novel features. 600 w. Eng News—May 5, 1898. No. 20072.

Safety Appliances.

Safety Appliances in Winding Shafts. Victor Watteyne and Armond Halleux From a report on the plant and methods of mine working at the Brussels International Exhibition of 1897. Illustrated description of apparatus for the protection of shafts at landings, for preventing the cage being drawn up to the pulleys, or attaining excessive speed, &c. 4000 w. Col Guard—May 13, 1898. No 20358 A.

Safety Lamps.

Some Notes on the Safety Lamp Problem. H. W. Halbaum. The object of the paper is to show that in some respects the incandescent lamp is inferior to the best form of Davy, as it introduces new sources of danger. 3300 w. Col Guard—April 29, 1898. Serial. 1st part. No. 20133 A.

Sand Blast.

Sand Blast Apparatus for Mining Purposes. Describes the construction and operation of the apparatus. 900 w. Eng & Min Jour—May 14, 1898. No. 20192.

Shot-Firing.

Electric Shot-Firing in Mines. Presents the advantages of the electric method over the fuse method, and gives essential particulars that should be carried out to obtain the best results. 1800 w. Elec Eng, Lond—May 13, 1898. No. 20337 A.

Unloading.

Coal Unloading Machines. W. B. Hanlon. An illustrated description of different types of car-dumping machines used at Lake Erie ports,

with an account of some earlier devices and the improvements to the present time. 4000 w. Mines & Min—May, 1898. No. 20063 C.

MISCELLANY.

Electric Furnaces.

See Electrical Engineering, Miscellany.

Iowa.

Iowa Mineral Production in 1897. H. Foster Bain. Summary of statistics of production of the various minerals mined in the State. 1100 w. Eng & Min Jour—May 7, 1898. No. 20110.

Lead Refining.

The Electrolytic Refining of Lead. Sherard Cowper-Coles. Describes the processes. 1000 w. Elec Rev, Lond—April 22, 1898. No. 20010 A.

Manganese.

The Manganese Ore Industry of the Trans-Caucasus. From a consular report by Consul Stevens of Batoum. Reports the industry in a deplorable condition. 900 w. Col Guard—May 6, 1898. No. 20240 A.

Metals.

The Metals Used by the Great Nations of Antiquity. J. H. Gladstone. Discourse delivered at the Royal Inst. Considers recent knowledge acquired concerning the metals used by different nations at different epochs of their history. 5800 w. Nature—April 21, 1898. No. 19995 A.

Mineralogical Museum.

The Mineralogical Museum of the Colorado State Mining Bureau in the Capitol Building, at Denver, Colorado. Presents its uses and advantages to miners and students, with illustrated description of interesting and peculiar minerals and specimens there shown. 4000 w. Mines & Min—May, 1898. No. 20068 C.

Mortality.

Mining Mortality in England and Wales. James Barrowman. Compares the last two decennial reports to see whether improvements in conditions affect the vital statistics; also makes comparison with other occupations. 1300 w. Col Guard—April 22, 1898. No. 20022 A.

Petroleum.

Petroleum Fields of California. Statistics of production in Southern California, during 1897. 1100 w. Am Mfr & Ir Wld—May 13, 1898. No. 20222.

South Wales.

Reports of the Inspectors of Mines for 1897. Shows the number of persons employed, output of minerals, accidents, &c. 1000 w. Col Guard—May 6, 1898. No. 20238 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene and its Importance as an Illuminating Material. (Das Acetylen und seine Bedeutung als Beleuchtungsmittel.) Dr. Karl Thomae. A discussion of the chemistry of acetylene and a description of its progress, especially on the Continent. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—April 30, May 7, 1898. No. 20426 each D.

Destruction of the Liquefied Acetylene Works at Jersey City. Official information, with report of the inquest and editorial comment. Ill. 9500 w. Pro Age—May 2, 1898. No. 20056.

Carbid.

The Cost of the Production of Calcium Carbid. (Kosten der Calciumcarbid-Darstellung.) A computation, based upon the thermochemical and dynamical equivalents, and including costs of plants of various sizes and kinds. 2000 w. Der Electro-Techniker—April 30, 1898. No. 20465 B.

The Quality of Calcium Carbid. Gives details of one or two of the most approved methods of analysis of calcium carbid. 1800 w. Jour Gas Lgt—May 17, 1898. No. 20384 A.

Charging.

Charging Apparatus for Small Works. R. Watson. Illustrates and describes a simple, efficient and cheap scoop-charging apparatus. 2000 w. Gas Engs Mag—May 10, 1898. No. 20327 A.

Cyanids.

The Production and Consumption of Cyanids. Part first presents the necessity of the gas manager keeping informed on the progress of processes for gold recovery in order to anticipate the demand for cyanids; and also to keep informed regarding its production from other sources. 2000 w. Jour Gas Lgt—May 10, 1898. Serial. 1st part. No. 20293 A.

Gaseous Pressures.

The Measurement of Small Gaseous Pressures. Charles F. Brush. Read before the Am. Assn. for the Advancement of Science. Discusses a modified form of McLeod gauge used by the author in investigations requiring measurement of slight pressures. Ill. 1800 w. Science—May 27, 1898. No. 20526.

Gas Stoves.

The Comparative Cost of Cooking by Gas and Coal. Thomas Fletcher. An attempt to fix the standards by which the relative costs can be compared, giving conclusions favoring the use of gas. 2000 w. Gas Wld—May 7, 1898. No. 20247 A.

The Gas-Stove Cooking Demonstration from a Gas Manager's Point of View. Norton H. Humphreys. Discusses the business methods for advertising gas cookers; the exhibitions, lectures, letting stoves on hire, and other expedients. 2800 w. Gas Wld—May 7, 1898. No. 20248 A.

Governor.

Automatic Gas Governor. An illustrated description of a system of automatically regulating

pressures and similar work, introduced by Frederic Maquaire. 900 w. Engng—April 29, 1898. No. 20139 A.

Municipal Ownership.

The Municipality and the Gas Supply, as Illustrated by the Experience of Philadelphia. L. S. Rowe. Presents a careful examination of the history of these works, the causes of the defects connected with the city management, the conditions under which the lease was effected with a discussion of questions of public policy, concluding that the step taken marks a retrograde movement. 6700 w. An of Am Acad—May, 1898. No. 20305 H.

Retorts.

Retort Heating. G. P. Lewis. The first of a series of articles discussing the principles and relative advantages of the several systems of heating retorts with gaseous fuel, and giving formulæ that will assist in lessening the work of calculation. 900 w. Gas Wld—May 14, 1898. Serial. 1st part. No. 20340 A.

Standard.

A New Standard of Luminosity. (Sur un Nouvel Etalon Lumineux.) Ch. Féry. Describing a method of obtaining a flame of acetylene of constant and uniform brilliancy, suitable for use as a standard of comparison for photometric measurements. 1200 w. Comptes Rendus—April 25, 1898. No. 20415 D.

Steam Raising.

Economical Methods of Raising Steam in Gas Works. C. Drury. Read at meeting of the North of England Gas Managers' Assn. Shows the need of steam in gas works and discusses the methods whose cheapness recommends them, giving especial attention to heating the boiler by means of waste gases from the retort settings. Discussion. 3800 w. Jour Gas Lgt—May 3, 1898. No. 20190 A.

Street Lighting.

Street Lighting by Incandescent Gas-Burners. Remarks, report and discussion at the meeting of the Eastern Counties Gas Managers' Assn. at Peterborough, Eng. 7200 w. Jour Gas Lgt—April 26, 1898. No. 20070 A.

Water Gas.

The Adoption of Carburetted Water Gas. D. Terrace. Read at meeting of the North of England Gas Managers' Assn. States a few of the advantages that led to the introduction into the various gas-works, with a short description of the working of the apparatus. Also discussion. Ill. 7500 w. Jour Gas Lgt—May 3, 1898. No. 20189 A.

Water Gas and Its Applications. Vivian B. Lewes. Briefly reviews the progress of water gas, the economic conditions which up to the present have prevented pure water gas from coming into general use, the success of carburetted water gas, and the history of the industry, noting also recent developments in manufacture which will probably influence its future. Discussion. 8000 w. Jour Soc of Arts—May 13, 1898. No. 20330 A.

Welsbach.

Kern's Incandescent Gas-Burner. A full abstract of the specification of the first patent, with illustrations accompanying it. 3000 w. Jour Gas Lgt—May 10, 1898. No. 20294 A.

The New Burner of the Welsbach Company. Favorable discussion of the new invention of M. Kern. 2000 w. Jour of Gas Lgt—May 10, 1898. No. 20292 A.

The New Welsbach Burner. Describes an invention of Ottmar Kern which nearly doubles the efficiency of the burner. 2200 w. Gas Wld—May 7, 1898. No. 20249 A.

SEWERAGE.

Filtration.

More About Filtration of Sewage Through Coal. Information from a paper by A. Bostock Hill, given in response to an inquiry. Gives details of the construction of the filter tried at Wolverhampton, Eng. 1400 w. Munic Engng—May, 1898. No. 20028 C.

Flushing.

Flushing Pipe Sewers. H. N. Ogden, Jr. Abstract of a paper read at meeting of Am Soc. of Civ. Engs. Reports experiments made on sewers of Ithaca, N. Y., and conclusions drawn from available information, with summary of discussion. 1600 w. Eng News—May 12, 1898. No. 20161.

Iron Pipe.

Iron Pipe for Sewers. Charles Carroll Brown. A criticism on the action taken in an Illinois city, with some of the objections to iron pipe. 800 w. Munic Engng—May, 1898. No. 20029 C.

Sewage.

Purification of Sewage in England. John W. Alvord. Read before the Illinois Soc. of Engs. and Surveyors. Describes a chemical system in use in the borough of Acton, a suburb of London, its operation and efficiency. 2000 w. Munic Engng—May, 1898. No. 20031 C.

Sewage Disposal.

What Electrolyzed Sea Water Has Accomplished. W. L. Hedenberg. Explains the methods invented by Albert E. Woolf and M. Hermite, giving reports of applications of the process and the results. 1500 w. Elec, N. Y.—May 18, 1898. No. 20287.

Sewerage Problems.

Rainfall and Run-Off in Relation to Sewerage Problems. Walter C. Parmley. A comprehensive study of this subject, presenting the difficulties and the remedies. 7200 w. Jour Assn of Engng Soc's—March, 1898. No. 19978 C.

STREETS AND PAVEMENTS.

Brick.

Brick Paving. Irving E. Howe. Gives a brief description of the construction, and a statement of cost of the brick paving on Seventh street in the city of Minneapolis, laid during the season of 1897. 1300 w. Jour Assn of Engng Soc's—March, 1898. No. 19980 C.

Street Cleaning.

Observations on Street-Cleaning Methods in European Cities. George E. Waring, Jr. Re-

port of observations made in the summer of 1896, based on an examination of the street-cleaning methods of Vienna, Budapest, Munich, Berlin, Cologne, Brussels, London, Birmingham, Paris, Turin and Genoa. 25500 w. Munic Affairs Sup—June, 1898. No. 20368 D.

Review of the General Work of the Department of Street Cleaning of New York. Reports of the mechanical department; final disposition, waste disposal, and the principal factors which make up the cost. Ill. 35000 w. Munic Af Sup—June, 1898. No. 20369 D.

The Labor Question in the Department of Street Cleaning. Deals with the adjustment of labor questions by the "Committee of 41" and the Board of Conference in New York. 3500 w. Munic Af Sup—June, 1898. No. 20371 D.

The Problem of Snow Removal in New York. Gives historical sketch relating to this work from 1881 to 1895 comparing with results since that date. 12500 w. Munic Af Sup—June, 1898. No. 20370 D.

WATER SUPPLY.

Bandora, Bombay.

The Sanitation of Bandora. John Wallace. A report and project of water supply, drainage and conservancy for this municipality. 7500 w. Ind & East Eng—April, 1898. No. 20289 D.

Chicago Works.

The Chicago Water-Works Extension Tunnels. Illustrated description of the design and methods of construction of the North East Lake tunnel. 6400 w. Eng Rec—May 21, 1898. Serial. 1st part. No. 20314.

Duluth, Minn.

The Municipal Water-Works of the city of Duluth, Minn. W. B. Patton. Describes the situation, geology and topography of the city, giving the history of the water supply, and the plans for an independent system covering the whole city. Ill. 5500 w. Eng News—May 5, 1898. No. 20071.

Frankfort, Germany.

The New Water-Works of Frankfort, Germany. James H. Fuertes. Illustrated description of a novel driven-well plant. 900 w. Eng Rec—May 21, 1898. No. 20315.

Hamilton, Ohio.

Hamilton and Its Water Works. Illustrated description of an artesian-well supply system. 1200 w. Fire & Water—April 30, 1898. No. 19993.

Hampton Court.

How Wolsey Obtained the Water Supply for Hampton Court. From the *Surrey Comet.* Brief historical account of the early water supply of this palace, with remarks on the value of the pipe and excellence of the work. 600 w. San Rec—May 13, 1898. No. 20328 A.

Intake.

The Construction of the New Cleveland Water-Works Intake. Illustrated description of the building of this 9-foot, brick-lined tunnel, 26000-feet long, which presented many difficulties overcome by novel methods of working. 5000 w. Eng Rec—May 7, 1898. No. 20090.

London Supply.

The Staines Reservoirs. Perry F. Nursey. Brief history of project, and the difficulties met, by which London is to be provided with an adequate water supply. The first sod was turned April 30, which inaugurated the important undertaking. 2700 w. Ind & Ir—May 6, 1898. No. 20241 A.

The Staines Reservoirs Scheme. A description of the works, with map. 800 w. Jour Gas Lgt. May 10, 1898. No. 20295 A.

Madison, Wis.

Report of the Water Board of Madison. Account of recent improvements and related matters. Ill. 1600 w. Fire & Water—May 7, 1898. No. 20121.

Meters.

Meterage at Madison, Wis. Explains the thorough success of the system and the results. 1400 w. Fire & Water—May 14, 1898. No. 20224.

Meter Testing.

Meter Testing in Baltimore, Md. Illustrates apparatus used. 500 w. Eng Rec—May 14, 1898. No. 20213.

Potable Water.

Potable Water: Its Supply and Distribution. W. J. Eden Crane. Reviews the various appliances and conductors for furnishing the people with drinking water and water for other purposes, since the earliest times. Ill. 3800 w. Ill Car & Build—April 22, 1898. No. 19973 A.

Pumping-Plant.

A Deep-Well Pumping Plant at Waukesha, Wis. J. W. Ledoux. Describes and illustrates the plant and reports tests made. Discussion. Ill. 4800 w. Pro of Engs' Club of Phila—April, 1898. No. 20304 D.

Regulations.

Oswego Water Regulations. A copy of the code of regulations issued for the guide of master plumbers. 1000 w. San Plumb—May 1, 1898. No. 20101.

Reservoir Losses.

The Loss of Water from Reservoirs by Seepage and Evaporation. L. G. Carpenter. Gives the results of a series of observations to determine the loss from seepage, on reservoirs near Fort Collins, Colo, with observations on evaporation. 9500 w, State Agricul Col, Ft. Collins, Colo—Bulletin 45—May, 1898. No. 20309 D.

Rockford, Ill.

Increasing the Water Supply of Rockford. Gives the general plan of the work, with suggestions for the avoidance of waste. Ill. 1200 w. Fire & Water—April 30, 1898. No. 19994.

Subaqueous Pipes.

Subaqueous Pipe Laying, Boston, Mass. Illustrated description of construction of several 36-inch submerged mains of the Metropolitan water-works. 1000 w. Eng Rec—May 14, 1898. No. 20214.

Wasted Water.

The Right to Shut Off Water. Abstract of

ruling of Court of Appeals in an action to restrain the water commission of Albany, N. Y., from cutting off supply of a consumer refusing to pay charges for wasted water. 1100 w. Eng Rec—May 7, 1898. No. 20087.

The Use of Water in Madison, Wis. A review of the probable use and waste of water in small cities. 1100 w. Eng Rec—May 7, 1898. No. 20088.

Water Mains.

Assessments for Water Mains. Review of a decision of the U. S. Supreme Court establishing the legality of a tax per front foot without regard to the cost of the main. 1000 w. Eng Rec—May 21, 1898. No. 20311.

Wells.

Artesian Bored Tube Wells. Maurice Ockenden. Read before the Civil and Mech. Eng's. Soc. of London. Reviews the means adopted for boring or drilling wells, giving ancient methods and the more important ones in present use. 2000 w. Col Guard—April 29, 1898. No. 20138 A.

MISCELLANY.

Annexations.

Suburban Annexations. A. F. Weber. Presents statistics showing that the movement is the recognition of new economic conditions. 1500 w. N Am Rev—May, 1898. No. 19982 D.

City Charter.

The Proposed New Charter for the City of San Francisco. Some features of this charter are presented with editorial comment. 4000 w. Eng News—May 26. 1898. No 20518.

Destructor.

Experiments with Rubbish Destructors in Berlin (Die Versuche mit der Müllverbrennung in Berlin.) A general report of the official tests of the destructors at Berlin, with data as to capacity, operation and working expenses. 2 articles. 5000 w. Gesundheits Ingenieur—April 15, 30, 1898. No. 20440 each B.

Garbage Destructors. A. E. Brooke Ridley. Briefly reviews the three principal systems of destructor plants as used at Shoreditch, Ealing, and Oldham. Ill. Elec, N. Y.—May 11, 1898. No. 20185.

Explosion.

Gas Explosion in the Cleveland Water-Works Tunnel. Describes an explosion of natural gas which killed or injured eight men. Caused by electricity. 700 w. Eng Rec—May 21, 1898. No. 20313.

Garbage.

Garbage Disposal. Thomas B. Carpenter. Reviews methods old and new, but concludes that no perfectly satisfactory method for all times and all places has yet been devised. 3300 w. San—May, 1898. No. 20042 D.

The Disposal of Waste Liquids from Garbage Reduction. Describes a method of evaporating these liquids which prevents odors and yields a revenue. 700 w. Eng Rec—May 7, 1898. No. 20089.

Municipal Rights.

The Right to Lease Public Works. A decision of the Utah Supreme Court forbidding the lease of the Ogden water-works to private parties. 1000 w. Eng Rec—May 14, 1898. No. 20209.

Quasi-Public Works.

A New Plan for the Control of Quasi-Public Works. J. D. Forrest. Presents a plan recently brought forward by Alfred F. Potts, which is, in brief, the management by disinterested trustees of institutions endowed for the purpose of rendering the public service at cost. 4500 w. Am Jour of Soc—May, 1898. No. 20202 D.

Wastes.

The Removal and Utilization of Animal Wastes and Bodies. (Die Beseitigung und Verwertung von Fleischabfällen und Tierischen Kadavern.) Dr. Haefcke. Description of the Otto apparatus for recovering all valuable matter from animal wastes, avoiding injury to public health. 1500 w. Zeitschr d Ver Deutscher Ing—April 16, 1898. No. 20423 D.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April, 1898. Detailed list and classified summary. 2800 w. R R Gaz—May 27, 1898. No. 20523.

India.

Recent Railway Policy in India. Horace Bell. A comprehensive view of the general railway policy, with criticisms and historical account of these railways, with important discussion. 16000 w. Jour Soc of Arts—April 29, 1898. No. 20143 A.

Mails.

The Cost of Carrying the United States Mails. Interesting statistics on the cost of transporting mails by railroad, aiming to show that the present compensation should not be reduced. 1800 w. R R Gaz—May 6, 1898. No. 20105.

M. C. B. Rules.

The M. C. B. Rules of Interchange. The proposed changes, and the discussion by the Jersey City lodge of the Car Inspectors' and Repair Men's Assn. 2800 w. R R Car Jour—May, 1898. No. 20116.

Railway Progress.

Presidential Address to the Institution of Mechanical Engineers. Samuel Waite Johnson. A review of British railway progress, with special reference to the Midland Railway. 3400 w. Engng—May 13, 1898. Serial. 1st part. No. 20357 A.

Resistance.

Atmospheric Resistance to the Motion of

Railroad Trains. W. F. M. Goss. From a paper read at the April meeting of the Western Ry. Club. Also editorial. Describes experiments made, and gives conclusions reached. 7000 w. R R Gaz—May 20, 1898. No. 20300.

FINANCIAL.

American Railways.

An English View of Our Railways. W. M. Acworth, in the London *Times*. Considering the financial aspects of American roads. 3200 w. Ry Age—April 20, 1898. No. 19991.

Canada.

The Development of the Railways of Canada. Walter E. Weyl. A critical discussion of the development, operation and present condition of the railways of the Dominion, with reference to the advantages and detriments of government assistance. 3500 w. Engineering Magazine—June, 1898. No. 20473 B.

Earnings.

Favorable Net Railway Returns. A summary of the first quarter of the work of roads in the United States, showing quite satisfactory returns. 1100 w. Bradstreet's—May 21, 1898. No. 20310.

Railroad Earnings Undiminished. Report of earnings on railways of the United States for month of April. 2200 w. Bradstreet's—May 14, 1898. No. 20188.

New South Wales.

Railways in New South Wales. Information taken from the annual Blue Book, compiled by T. A. Coghlan, the government statistician of the colony. The growth and progress of the railways, which are largely under state control, with receipts. 1200 w. Transport—April 22, 1898. No. 19997 A.

LEGAL.

Address.

Address of M. E. Ingalls before the Convention of Railroad Commissioners. Discusses the maintenance of tariffs, and the changes that should be made in the present legislation. 3500 w. Ry Age—May 13, 1898. No. 20225.

Arbitration.

The Federal Arbitration Law. Abstract of the arbitration bill of Senator Kyle which has passed through congress, with brief editorial comment. 1500 w. R R Gaz—May 27, 1898. No. 20524.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Piston Travel, Means of Adjustment and Its Effect Upon the Handling of Trains. Abstract of report to the Assn. of Railroad Air Brake Men, Baltimore meeting. 2700 w. R R Car Jour—May, 1898. No. 20115.

The M. C. B. Standard for Air Brakes. Editorial discussion of the proposed action of the Am. Ry. Assn. in regard to the application of air-brakes to freight cars. Reviews the past history and discusses the present situation. 1800 w. Eng News—May 19, 1898. No. 20273.

Locomotive.

Consolidation Freight Locomotive; Southern Ry. Drawings, dimensions and interesting features of heavy engines built by the Richmond Locomotive & Machine Works. 500 w. Eng News—May 5, 1898. No. 20075.

Early Baldwin Locomotives on the Pennsylvania Railroad. Illustrations showing two types built between 1853 and 1856, with information concerning them. 900 w. R R Gaz—May 6, 1898. No. 20104.

Four Cylinder Compound Passenger Engine, London and North-Western Railway. Illustrated detailed description. 900 w. Engr, Lond—May 6, 1898. No. 20235 A.

The Battle of Rainhill. N. O. Whitney. An interesting account of means of transportation in the district comprising Liverpool and Manchester, Eng., with special reference to the success of George Stephenson's "Rocket." 1800 w. Wis Engr—Jan , 1898. No. 20275 D.

M. C. B. Couplers.

A New Standard Needed for M. C. B. Couplers. An editorial review of the history of the M. C. B. coupler and the present situation. 1400 w. Eng News—May 5, 1898. No. 20073.

Motor Cars.

Steam Motor Cars for Minor Railway Lines. Illustrates the combination cars built by the Baldwin Works of Phila., for the C. H. & D. railroad. 1000 w. Ry Wld—May 5, 1898. No. 20362 A.

Train Lighting.

The Dick System of Electric Train Lighting. (Elektrische Zugbeleuchtung. System Dick.) The system uses accumulators charged by a dynamo on one car axle. A full description is given and an account of practical experience on the local railway between Vienna and St. Pölten. 5000 w. Electrotech Zeitschr—April 28, 1898. No. 20452 B.

Truck.

Special Brill Truck for a 96,000-lb. Locomotive Passenger Car. Illustrates a special truck built for a locomotive-passenger car being constructed in France for high-speed electric railway service. 900 w. Eng News—May 19, 1898. No. 20271.

Wheels.

Steel Tired Versus Chilled Iron Wheels. H. M. Boies. A reply to Mr. Sanderson's paper on chilled cast iron wheels. Thinks cast iron cannot be made strong enough or cast drilled wheels uniformly reliable enough to meet the requirement of present railway service. 2800 w. R R Gaz—May 13, 1898. No. 20196.

NEW PROJECTS.

China.

Notes from China. Photographs, with information furnished by Mr. Grant Birch, of the firm of Messrs John Birch & Co., Limited, London, showing the quite respectable amount of railway work in China and giving interesting facts relating to the different lines. 2700 w. Engng—May 13, 1898. No. 20355 A.

The Position of Railway Development in China. Review of lines existing and projected, with map. 1200 w. Ir & Coal Trds Rev—May 13, 1898. No. 20346 A.

The Railways of China, Existing and Prospective. Andrei Kmita. Reviews the work already completed, and gives information concerning prospective railways. Map. 2300 w. Am Eng & R R Jour—May, 1898. No. 19-986 C.

India.

The Nilgiri Railway. Benson P. Wall. Interesting particulars of a recently constructed mountain railway of India. 2800 w. Ind & East Eng—April, 1898. No. 20288 D.

Railway Widening.

The South-Western Railway Widening at Battersea. Brief account of the widening and bridge building between Vauxhall and Clapham Junction on this English road. 1200 w. Engr, Lond—May 13, 1898. No. 20352 A.

South Africa.

Railway Building in South Africa. Interesting interview with Frank Esmonde White, who has recently returned from Bechuanaland, giving a résumé of the work, its present stage and probable development. 1200 w. Ry & Engng Rev—May 14, 1898. No. 20208.

Trans-Siberian Railway.

The Trans-Siberian Railway: Its New Terminus in China. Clarence Cary. An interesting account of the work thus far accomplished, making a connected steam route run possible, by the use of the Amoor river; and a presentation of existing conditions and the work remaining. 6000 w. Forum—May, 1898. No. 20040 D.

See also Mining and Metallurgy, Gold.

PERMANENT WAY AND FIXTURES.

Boston Station.

Waterproofing and Drainage at the New South Terminal Station in Boston. Some portions of the station lying below high-tide level, has made necessary an extensive covering of waterproof material, and the method adopted is described, with drawings. 800 w. R R Gaz—May 6, 1898. No. 20102.

Crossings.

Railway Crossings in Europe and America. Franklin B. Locke. An interesting illustrated account of recent improvements and of the service in Europe and America, with comparisons and important information. 9000 w. Century Mag—May, 1898. No. 19944 D.

Interlocking.

Releasing Device for Interlocking Plants. Describes a new and interesting form of mechanical release for the electric locks which has been introduced in a plant installed at East Clinton, Ill. Ill. 800 w. Eng News—May 12, 1898. No. 20156.

Joint Station.

Rock Island and Lake Shore Work at Englewood. Illustrates and describes a joint station for three roads to be erected at Englewood (Chicago), in connection with the elevation of the tracks. 800 w. Ry Age—May 20, 1898. No. 20320.

Paris Railways.

The New Lines of the Western Railway of France. (Les Nouvelles Lignes de la Compagnie l'Ouest.) An account of the new connections of the Western Railway within the city limits and in the environs of Paris, with numerous illustrations and plans. 3500 w. 1 plate. Le Génie Civil—May 7, 1898. No. 20407 D.

Rails.

On the Wear of Steel Rails. G. Olva. Abstract published by the Inst. of Civ. Engs. (British) relating to the life of rails. 1100 w. R R Gaz—May 20, 1898. No. 20298.

Steel Permanent Way. Richard Price-Williams. Read at meeting of the Iron and Steel Inst. (London). Shows that the enormous traffic and tractive power of the present have made steel rails a necessity; that there has been a continued decrease in cost of maintenance of way and rolling stock; calling attention to weak points needing remedy. Discussion. 10200 w. Ir & St Trds Jour—May 14, 1898. No. 20-331 A.

Signals.

An Improved Lever Compensator for Wires to Distant Signals. F. G. Lynde. Discusses the causes of uncertainty in successfully working distant signals and describes a mechanism intended to counteract the defects. Ill. 1500 w. Ind Engng—April 2, 1898. No. 20080 D.

Stresses.

Stresses in Rails Under Moving Loads. P. H. Dudley, in a lecture before the N. Y. Academy of Sciences. Describes the principle and use of the stremmatograph, giving records obtained with it. 2500 w. R R Gaz—May 20, 1898. No. 20296.

Terminal.

The New Terminal Station of the Orleans Railway. (Nouvelle Gare Terminus de la Cie d'Orleans.) An illustrated account of the extension of the road to the quai d'Orsay, and the preparatory demolition works for the new station in Paris. 3500 w. 1 plate. Le Génie Civil—April 16, 1898. No. 20403 D.

Train Motion.

The Motion of Locomotives and Cars on Tangents and Curves. A. Von Borries. Extracts translated from an important work, "Die Eisenbahn-Technik der Gegenwart," by W. W. Nichols. Discusses the quality of the motion, especially as regards the action of the forces developed. 1800 w. R R Gaz—May 6, 1898. No. 20106.

Train Protection.

System for Protection of Railway Trains. Emile Dieudonné. Translated from *La Vie Scientifique*. Brief account of a protecting system devised by MM. Chauvin and Baulan, which enables a stalled train to communicate with neighboring stations, signal towers, etc., or to announce its presence to approaching trains. 1200 w. Elec, N. Y.—May 11, 1898. No. 20186.

STREET AND ELECTRIC TRAMWAYS.

Accumulator Traction.

A Critique of Accumulator Traction. Abstract of a report, giving the conclusions of the deputation of the Blackpool Corporation on Continental Systems of Electric Traction. Conclusions favor the overhead trolley. 1600 w. Elect'n, Lond — April 29, 1898. No. 20146 A.

Algiers.

Electric Traction at Algiers. Description, with interesting photographs, of the first electric tramway in French dominions in Africa, with brief account of previous mode of transport. 1400 w. Ry Wld—May 5, 1898, No. 20361 A.

Aluminum Wires.

Aluminum Wires for Overhead Lines. Stuart A. Russell. Refers to statements made in paper by A. E. Hunt, and gives examples showing that they must be modified when the effect of wind pressure is taken into account. 900 w. Elec Rev, Lond—April 22, 1898. No. 20007 A.

Berlin.

The Electric Railway in the City of Berlin. (Die Elektrische Stadtbahn in Berlin.) M. Foerster. With map, views of elevated structure and details of construction. Serial. 1st part. 3000 w. 1 plate. Stahl und Eisen—May 1, 1898. No. 20445 D.

The Introduction of Electric Power on Berlin Tramways. (Einführung des Elektrischen Betriebes auf den Linien der Grossen Berliner Strassenbahn.) With views of the cars and trucks, showing the arrangement of motors and suspension. 2500 w. Electrotech Zeitschr—May 5, 1898. No. 20456 B.

Booster System.

The Booster System as Applied to Electric Railways. J. Lester Woodbridge. Shows the arrangement of booster, explaining its aim, and operation and discussing the economy. 3000 w. Jour Fr Inst—May, 1898. No. 19947 D.

Connecticut Lines.

Third Rail versus Trolley in Connecticut. Editorial discussion of the rivalry, and the interesting phases of the situation. 1600 w. R R Gaz—May 6, 1898. No. 20107.

Counterweight System.

Counterweight System in St. Paul. Illustrates and describes the system invented by M. H. Bronsdon, which is being installed to replace that part of the cable railway known as Selby Hill. 1500 w. St Ry Rev—May 15, 1898. No. 20204 C.

Earth Returns.

Earth Returns for Electric Tramways. H. F. Parshall. Read before the Inst. of Elec. Engs., England. Considers various types of bonds, welding, and the subject generally, reporting tests and means of preventing electrolysis. 4000 w. Engng—May 6, 1898. No. 20234 A.

Earth Returns for Electric Tramways. H. F. Parshall. Part first reports results of tests showing that a large fraction of the current returns through the earth itself, and presents the necessity of determining the conductivity of the rails, fish plates, and bonds before the track is laid in the earth. Discusses the method of jointing and the composition of the rails, bonds, &c. 2200 w. Elec Eng, Lond—April 29, 1898. Serial. 1st part. No. 20145 A.

Electrolysis.

The Ground Current of Electric Railways. Albert B. Herrick. A discussion of the causes and effects of electrolysis, showing why water pipes and other underground conductors are corroded, together with various methods for preventing such action. 3000 w. Engineering Magazine—June, 1898. No. 20479 B.

English Tramways.

English Electric Street Railroads. Some of the difficulties met by promoters of street railway schemes, the concessions which have been secured, and some that have failed. 1200 w. R R Gaz—May 6, 1898. No. 20103.

Equipment.

New Electrical Equipment of the South Side Elevated Railroad, Chicago. J. R. Cravath. Illustrated description of the interesting features brought out by the change of motive power from steam to electricity. 4300 w. Elec Eng, N. Y.—May 5, 1898. No. 20045.

Germany.

Electric Traction in Germany. Calls attention to some points brought out by Edwin Houswald, in a paper read before the Electrotechnical Society of Berlin. Gives a summary of the new features of accumulator working. 1200 w. Engr, Lond—May 13, 1898. No. 20351 A.

Japan.

Electric Railroad Building in Japan. Map of proposed lines in Tokio, with information concerning the companies formed, systems adopted, &c. 800 w. R R Gaz—May 20, 1898. No. 20301.

Jungfrau.

The Jungfrau Railway. (Ueber die Jungfraubahn.) A finely illustrated paper read before the German Railway Society by Dr. Wrubel, giving an account of the preliminary work, plans, rolling stock and motive power of this most important piece of mountain electric railway work. 7500 w. Glaser's Annalen—May 1, 1898. No. 20435 D.

Leeds.

The Cost of Electric Traction: Leeds Electric Tramways. Figures relating to the cost of construction and working of this English line, with editorial comment. 2800 w. Ry Wld—May 5, 1898. No. 20363 A.

Nottingham.

Nottingham Tramways. Report of the Corporation's committee, with critical review. The

committee recommend the adoption of the overhead trolley system, and the reconstruction of the existing system, and many extensions. 4000 w. Ry Wld—May 5, 1898. No. 20364 A.

Paris.

Electrical Tramways in Paris. R. T. Collins. Extract from an article in the supplement to the *Contract Journal*. Illustrated description of the systems in use; the overhead trolley is excluded. 3500 w. Elec Eng, Lond—April 22, 1898. No. 20013 A.

Power Plant.

St. Anthony's Falls Water Power Plant. Illustrated full description of plant constructed to furnish power to all the street railway systems of Minneapolis and St. Paul. 2800 w. St Ry Jour—May, 1898. No. 20039 D.

Power Station.

Power Station of the South Side Elevated Railroad. Illustrated description of this Chicago station for furnishing power to the Sprague multi-unit system recently adopted. 1600 w. St Ry Rev—May 15, 1898. No. 20205 C.

Rack Railway.

The Eisenerz-Vordernberg Railway. (Die Eisenbahn Eisenerz-Vordernberg.) An interesting illustrated description of this combined adhesion and rack railway near Vienna, with profile, topographical map and details of rolling stock. 7500 w. Glaser's Annalen—April 15, 1898. No. 20434 D.

The Electric Rack Railway to the Gornergrat. (Die Elektrische Zahnradbahn auf den Gornergrat.) A very full descriptive account of the new road now partially constructed from Zermatt to the Gornergrat, in the Bernese Oberland. Four articles, 8000 w. Schweizerische Bauzeitung—April 16, 23, 30, May 7, 1898. No. 20439 each B.

Reports.

Report of Massachusetts Street Railways. Information from the Railroad Commissioners' report for 1897. 1200 w. St Ry Rev—May 15, 1898. No. 20207 C.

Street Railway Work.

The New Work of the Metropolitan Street Railway Company of New York. Illustrates and describes some features of the electrical construction and station equipment. 1200 w. Elec Eng, N. Y.—May 12, 1898. No. 20167.

Tramways.

Notes on Electric Tramways. Major P. Cardew, and A. P. Trotter. Read before the Inst. of Elec. Engs., England. Explains a graphical method for determining the fall of potential in the return with uniform distribution of current, and also notes advocating the automatic regulation of this fall of potential. 1800 w. Elect'n, Lond—April 29, 1898. No. 20149 A.

Tubular Line.

The Brompton and Piccadilly Circus Railway. Some facts concerning this deep-level tubular electric line and its connections, with map. 400 w. Transport—April 22, 1898. No. 19996 A.

BOOKS OF THE MONTH

THE RESISTANCE AND PROPULSION OF SHIPS. By William F. Durand, Principal of the School of Marine Construction, Cornell University New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Since the publication of the great treatises by such men as Rankine and Scott Russell, the greater part of the additions to the literature relating to the resistance and propulsion of ships has been made public in the transactions of scientific societies or in the technical press. For this reason any attempt to collect the data relating to the subject has been attended with much labor and inconvenience, and the results have necessarily lacked coherence and unity.

Professor Durand has worked this mine of information and research to good purpose, and has supplemented the work of others with his own efforts, and the present volume is the result.

Originally intended to serve as lectures to the students in the school of marine construction at Cornell University, the work in its present form suggests the text book, although not to such an extent as to make it unsuitable for reference in connection with the work of the marine engineer and architect.

Starting with the general subject of the resistance to the motion of a solid in a liquid this being very fully and clearly treated, a chapter on propulsion follows, in which screw propellers, paddle wheels and hydraulic jets are given due consideration. The reaction between ship and propeller is next taken up, this being treated mathematically and apart from consideration of constructive details.

The questions of propeller design and the computation of power are discussed successively, and the work closes with a chapter on trial trips.

While a free use has been made of the calculus where the nature of the subject demands it, the book as a whole is much freer from mathematics than others treating of similar subjects, and makes no greater demands upon the reader's capacity in this respect than any fairly well informed engineering student should be readily capable of meeting. The methods are amply illustrated by examples and the explanations are so clearly given as to render the work a valuable contribution to the science and practice of marine engineering.

THE NEW ROADMASTER'S ASSISTANT. A Manual of Reference for those having to do with the Permanent Way of American Railroads. By George Hebard Paine. New York: *The Railroad Gazette*. 1898.

This is an entirely new work on the lines of the book known as the Roadmaster's Assistant, written twenty-seven years ago by Wm. S. Huntington and afterwards revised by Charles Latimer.

Since the appearance of the original work the changes in methods and materials have rendered many changes necessary in discussing the work of those "having to do with permanent way," and the result is the book now before us.

Mr. Paine has done his work well, and there can be but little doubt that such a book will inspire trackmen to do better work and make better track. The related subjects of water supply, drainage, culverts, trestles, and bridge floors, ballast, cross ties, rails and fastenings, are preceded by general remarks on organization and methods of work, and followed by chapters on tools, emergencies, and signals, with a collection of such simple rules and tables as may be needed. The book is refreshingly practical in every way, and the freedom with which illustrations are used must appeal to the working trackman in a way which no elaborate explanations could ever do. It does seem that with energy, opportunity, and a careful study of this little handbook, almost any man so disposed, could fit himself to become a competent overseer of permanent

way, from the time it is turned over by the contractors to the company.

The work is excellently printed, with wide margins, and marginal "catch notes," so that the subject matter of any page can be taken in at a glance, and the flexible cover, with round corners makes it especially convenient for the pocket.

THE AUTOMOTOR AND HORSELESS VEHICLE POCKET BOOK OF AUTOMOTIVE FORMULÆ AND COMMERCIAL INTELLIGENCE, 1898. Compiled by Geo. Herbert Little, C. E. London: F. King & Co., Ltd. 212 pages. Flexible leather cover.

A decidedly convenient and useful volume; just the thing to be carried in the box of an automotor. It contains an almanac, a log (diary) in which the particulars of a journey may be set down. There are also many appropriate formulæ which we shall not attempt to discuss.

Tables there are, lists of clubs and associations, of individuals, of periodicals and of firms employed in building automotors and automotive materials.

Last, but not least, are the advertisements of which there are many (but not enough) and which should in time prove of the greatest value to a possessor of the book.

HIGH MASONRY DAMS. By E. Sherman Gould. New York: D. Van Nostrand Company. Pasteboard cover. 88 pages.

One is here brought in a very simple manner from the fundamental subject of the static stresses through unit stress, etc., up to the final point — the exact form of the vertical section. This wise little monograph does not, so far as we can see, make use of a single formula which involves an operation more complicated than the extraction of cube root. Thirteen pages are devoted to hints regarding Construction and eleven pages to Accessories, which includes spillways, waste culverts, gates valves and cocks. These last twenty-four pages are entertaining as well as instructive.

The whole eighty-eight pages are simple enough for the student just entering an engineering school and sufficiently conclusive for the practicing engineer.

BOOKS RECEIVED.

Theory and Calculation of Cantilever Bridges. By R. M. Wilcox, Ph. B. New York: D. Van Nostrand Company.

Lighting by Acetylene. By William E. Gibbs, M. E. New York: D. Van Nostrand Company.

Fire Service in Factories, Works, &c. By Harold Sumner. London: The British Fire Protection Committee.

The Metric System of Weights and Measures. By H. M. Lane. Cincinnati, O.: The Manufacturers' Club.

American Cements. By Uriah Cummings. Boston: Rogers & Manson. 1898.

Industrial Electricity. From the French of H. de Graffigny, edited by A. G. Elliott, B. Sc. London and New York: Whittaker & Co. 1898.

A Laboratory Guide in Qualitative Chemical Analysis. By H. L. Wells, M. A. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

A Short Course in Inorganic Qualitative Analysis for Engineering Students. By J. S. C. Wells, Ph. D. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The New Roadmaster's Assistant. By George Hebard Paine. New York: The Railroad Gazette. 1898.

Exposition Internationale d'Electricité. Règlement et Programmes. Come: Imprimerie Cooperative. 1898.

Fire Resisting Floors used in London. By Frederic R. Farrow. London: The British Fire Prevention Committee. 1898.

Cotton Fires and Cotton Bales. By R. H. Scotter, C. E. London: The British Fire Prevention Committee. 1898.

Preliminary Report on the Income Account of Railways in the United States for the year ending June 30, 1897. Washington: Government Printing Office. 1898.

Annual Report of the Water Commissioners of the City of Binghamton. Binghamton, New York: Binghamton Chronicle.

Third Annual Report of the Metropolitan Water Board, Boston: Wright & Potter. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

J. Bagshawe & Sons, Ltd., Victory Foundry, Batley, England.=Illustrated price list of wrought iron pulleys, shafting and friction couplings. Practical rules for the transmission of power and safe loads for steel and iron girders are given, as well as particulars of a sand mixing machine.

Andrew Handyside & Co., Ltd., Derby, England.=Handsome photo book of bridges and iron and steel structures. The length of the spans, height and weight of steel work used are given in each case. 30 illustrations.

J. H. Holmes & Co., Newcastle-upon-Tyne, England.=Illustrated catalogues (*a*) of the "Castle" dynamos and motors for electric lighting; (*b*) of the "Lundell" continuous current electric motors for power transmission; (*c*) well printed circular describing the use of the electric motor on printing machinery.

Alley & Maclellan. Polmadie, Glasgow, Scotland.=Well printed and illustrated catalogue of the "Sentinel" (Westinghouse type.) high-speed engine, including information on the repair system, method of operation, and economy. Both simple and compound types are made, and half-tone blocks illustrate the engine applied to pumps, fans, electric lighting, and other plant.

D. A. Rankine, Oriel Chambers, Water St., Liverpool, England.=Circular describing Rankine's patent feed water filters for land and marine boilers. The "Single Cartridge," multiple and compound types are described.

The Kingfisher Patent Lubrication Co., Leeds, England.=Three circulars (*a*) of automatic screw-plunger lubricators, and of lubricants; (*b*) of the "Emissary" patent electrical lubricant (*c*) of jointing cement and preservative paint.

A Keiffenheim & Sons, Prudential Bldgs., Newcastle, England.=Circular giving list of alloys, rare metals and minerals.

Davey Paxman & Co., Ltd., Colchester, England.=(*a*) Catalogue of steam engines and boilers, including all usual types of pumps, air compressors and mining machinery; (*b*) Price-list of same.

Lumby, Son & Wood, Ltd., Halifax, England. =Catalogue of the "Pioneer" boiler for hot water and steam heating purposes, describing eight types in all; also useful information for engineers at end. Full dimensions, prices, and description.

Roller-Bearings Company, Ltd., 1 Delahay St., Westminster, London.=Photo book showing the application of roller bearings to railway carriages, tramcars, shafting, etc., with list of purposes to which they have already been applied.

Thomas Henderson, 8 Trueman St., Liverpool, England.=Three circulars (*a*) describing self-cleaning firebar furnaces, and the "Simplex" patent mechanical stoker; (*b*) giving results of tests of self-cleaning furnaces applied to marine boilers; (*c*) describing Henderson's improved mechanical stoker.

R. Robson, 12 Lisle St., Newcastle-on-Tyne, England.=(*a*) Price list of grindstones; (*b*) Price-list of cube and flat stones.

Edwin Clark & Co., Ltd., Canal Side, Brimscombe, England.=(*a*) Catalogue of engines, boilers, valves and fittings, for marine purposes, also of steering wheels, capstans, etc; fully illustrated with dimensions and prices; (*b*) Illustrated description of Brimscombe district with an account of Messrs. Clark & Co.'s works.

Rosling & Appelby, Bradford, Yorkshire, England.=Illustrated catalogue of dynamos, motors, electrical mining, pumping, hauling and coal cutting machinery. Specifications, prices and sizes are given in most cases.

George Green, Aberystwyth, South Wales. Catalogue of mining machinery, steam engines and boilers, stone breakers, crushing rolls, trommels and jiggers. Full descriptions and illustrations.

The Ipswich Tannery, Ltd., Ipswich, Suffolk, England.=Circular entitled "Comparative Tests of Leather Beltings, also giving prices of the oak bark tanned "Hydra" belting.

Ernest Scott and Mountain, Ltd., Close Works, Newcastle-on-Tyne, England =Handsome cloth bound catalogue of electrical plant and machinery, arc lamps, projectors, accumulators, as well as of high speed steam engines and auxiliary machinery for ships. Fully illustrated with sizes and prices. A considerable section is given to electrical mining plants.

Barrows & Co., Ltd., Banbury, Oxon, England. =Illustrated catalogue of steam engines, boilers, and agricultural machinery, with description; also detatched price list of this machinery.

Dorman, Long & Co., Ltd., Middlesborough, England.=Section book of beams, joists, angles, tees, channels, bulb, angles, and other structural shapes; well bound in stiff paper cover. For each section safe loads, sizes, areas, inertias, and other data are given; also details of box girders and built-up structural work.

Paris, Singer & Co., Manor Street, Clapham, London.=Price list of high speed gas engines and specially light oil motors for cars and cycle work.

F. Reddaway & Co., Ltd., Pendleton, Manchester, England.=Illustrated eight page price list of "Sphincter Grip" armoured hose; also particulars of a high pressure hydraulic coupling, of unions and of gardening requisites.

Wm. Brenton, Ltd., Polbathic, St. Germans, Cornwall, England.=(*a*) Price list of agricultural machinery, principally corn and root drills; (*b*) Price list of lock-pin safety bolts, and of carriage lifting jacks.

Wilson & Gillie, New Quay, North Shields, England.=Circular descriptive of specialties in navigation instruments.

The Hoppes Mfg. Co., Springfield, Ohio, U. S. A.=General catalogue of the Hoppes feed

water purifiers and heaters for use either with live or exhaust steam. The construction and action of the heater is explained and a large list of users appended.

Thomson Electric Welding Co., Lynn, Massachusetts, U. S. A.=Handsomely illustrated pamphlet showing apparatus for electric welding, tempering, annealing, brazing, forging, and shaping of metals by means of the methods invented by Prof. Elihu Thomson.

Gorton & Lidgerwood Co., New York.=Modern House Heating. A handsome catalogue of the Gorton side-feed boilers, as arranged for either steam or hot-water heating, with forms of specifications, plans of buildings and much useful information.

The Lunkenheimer Co., Cincinnati, Ohio, U. S. A.=Illustrated catalogue and price list of valves, injectors, whistles, lubricators, oil and grease cups, and steam specialties. A very complete list of standard steam fittings, together with useful charts of dimensions for use in making up plans of piping systems.

Chandler and Taylor Co., Indianapolis, Indiana, U. S. A.=A very beautiful catalogue of high-class automatic cut off steam engines, showing various sizes and designs, with tabulated specifications.

Niagara Radiator Company, Buffalo, New York, U. S. A.=Price list and dimension sheets of the Niagara radiators for use in steam or hot-water heating. Many handsome designs are shown for a variety of uses.

Dearborn Drug and Chemical Works, Chicago, Illinois, U. S. A.=Pamphlet catalogue devoted to (*a*) lubricating oils for engines and machinery; (*b*) the treatment of boiler feed water for the prevention of the formation of scale. Directions for submitting samples of feed water for analysis are given, as well as useful data concerning the selection of lubricants.

Stackpole & Brother, New York=Price list and catalogue of surveying instruments, including levels, transits, theodolites, sextants, &c. Detailed descriptions are given of Y level, plain transit and vertical circle transit, with illustrations.

The American Stoker Company, New York.=A finely illustrated catalogue of the American underfeed stoker, showing its application to various classes of furnaces, together with tabulated results of tests, and testimonials from users. A handsome piece of typography and engraving.

General Electric Company, Schenectady, New York, U. S. A.=Pamphlet catalogue No. 9060, illustrating and describing fan motors for direct and alternating currents.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of recent construction, No. 5, June, 1898, with illustrations and specifications of locomotives recently completed for railways in various parts of the world.

C. W. Hunt Company, New York.=Two pamphlet catalogues, (*No. 9803*) describing the Hunt cable railways, as used for handling coal and merchandise; (*No. 9806*) illustrating the Hunt automatic railway for the mechanical unloading and dumping of coal. Both are handsomely illustrated and contain descriptions of numerous important installations.

Buffalo Forge Company, Buffalo, New York, U. S. A.=Illustrated pamphlet describing a modern blacksmith's shop, as equipped with improved tools, blowers, exhausters drills, shears, &c., forming a sketch of a 19th century American smithy.

Cincinnati Screw and Tap Co., Cincinnati, Ohio, U. S. A.=Collection of circulars of set and cap screws, stud bolts, nuts, and special bolts; also taps, reamers, and other small tools. Catalogue No. 7 will be sent on application.

Ferracute Machine Company, Bridgeton, New Jersey, U. S. A.=Large illustrated sheet (*No. 301*) of foot and power presses for stamping and drawing all kinds of sheet metal, giving weights, prices, and brief description.

The Electric Storage Battery Co., Philadelphia, Pa., U. S. A.=Circular *No. 40*, illustrating the application of storage batteries to isolated plants by describing a residence lighting plant installed in a private mansion at Wayne, near Philadelphia.

J. A. Fay & Co., Cincinnati, Ohio, U. S. A.=Large illustrated sheet, showing woodworking machinery of all kinds, with brief descriptions.

Bingham & Co., Philadelphia, Pa., U. S. A.=Small pamphlet catalogue describing the "Common Sense" exhaust head, for muffling the discharge from exhaust steam pipes, and catching the grease and condensed steam.

The Yale & Towne Mfg. Co., Stamford, Conn., U. S. A.=Handsomely printed pamphlet of "Vulcan" standard locks, composed entirely of wrought metal. A beautiful piece of typography and engraving, showing the construction and operation of the locks in a very clear manner.